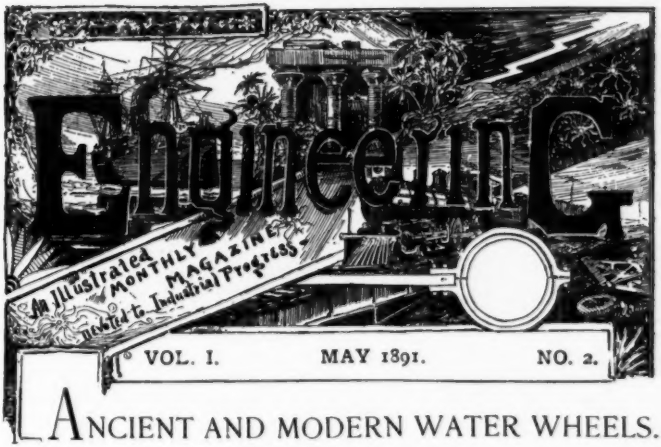

ANCIENT AND MODERN WATER WHEELS.

By Samuel Webber, M. E., C. E.

WATER is ever in motion. Whether pouring down from the hillsides in an impetuous torrent, whether creeping slowly through wide meadows, or heaving with the long swell of ocean, it is never still. Even when apparently sleeping in some quiet lake or pond, it is constantly either permeating the soil below or rising in invisible vapor to the skies under the action of the sun and air, to form clouds, to be condensed into rain and to return again to the earth, repeating forever its beneficent and fertilizing mission.

Which of the two great elements of Nature, air or water, the sons of Earth first called to their aid in the labors of procuring and preparing the many things necessary to existence it is difficult to say. The wind which moved their rude canoes over the surface of the waters was no doubt used at a very early period for other purposes, but we do not propose to investigate that question here. The use of water for irrigating purposes can be traced far back into the dawn of history, and the Chinese claim to have raised water from the rivers for that purpose as early as 1000 years before Christ, by the use of the simple wheel known as a "Noria," of which a representation is given. These wheels are constructed entirely of bamboo. Into a central shaft are inserted 16 or 18 pairs of spokes obliquely, crossing each other about two-thirds of

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their length from the centre, and are there firmly lashed together with strips of the same material, and cross-bars of the same are lashed across the ends. The triangle thus formed is filled in with a basket-work of bamboo shreds, which catch the force of the current and revolves the wheel. Attached to the end of each vane is a bucket, also of bamboo, with one of the natural joints left in to form a bottom, and cut off diagonally at the other end, these buckets being so placed that when on a level with the axle they will form an angle of 20 degrees with the horizon. The buckets dip into the water with every revolution, and being carried around by the force of the current rise full of water, and on reaching the top discharge it into a trough which conveys it to their irrigating canals.

Every piece of this structure, axle, spokes, buckets and floats is of bamboo, all lashed together with split fibres of the same. These wheels are from 20 to 40 feet in diameter, according to the height of the bank over which the water is to be raised.

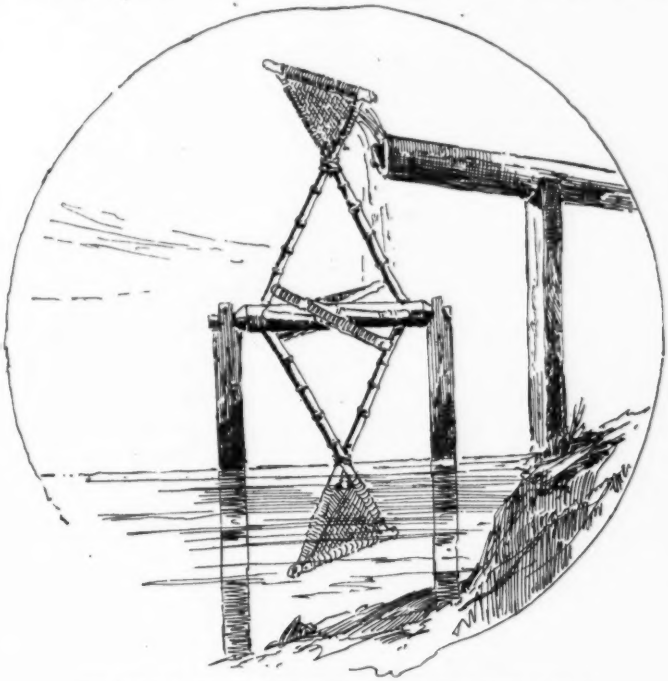
A wheel of 30 feet diameter carries 20 tubes or buckets, each about 4 feet long and 2 inches in diameter, holding about six-tenths of a gallon, or 12 gallons in the whole. With a stream of moderate velocity such a wheel would make four revolutions per minute and would lift 48 gallons of water, or nearly 70,000 gallons a day. The use of such wheels was not confined to China. They were probably known to all the Oriental nations and were also used on the Nile and the Euphrates.

The following interesting description is taken from a report on the navigation of the Euphrates by Colonel Chesney, of the British Army :

"The scenery above the town of Hit, in itself very picturesque, is greatly heightened by the frequent recurrence at very short intervals of ancient irrigating aqueducts. These beautiful specimens of art and durability literally cover both banks, and prove that the borders of the Euphrates were once thickly inhabited by a people far advanced in the application of hydraulics to domestic purposes of the first and greatest utility, the transport of water.

"These speaking monuments of other times have, as may be supposed, suffered in various degrees during the lapse of so many ages of partial or entire neglect, and the greater portion are now more or less in ruins; but some have been repaired and kept up for use, either to grind corn or to irrigate, having a modern wheel attached to the ancient simple and most efficient model, the whole being in some instances sufficiently well preserved to show clearly the original application of the machinery.

"The aqueducts are of stone, firmly cemented, narrowing about 2 feet, or twenty inches, at top, placed at right angles to the current, and carried various distances towards the interior from 200 to 1200 yards, their height being regulated by the level of the ground to be irrigated; the shorter distances have one height of arches and the larger ones two, one above the other, both extremely pointed; in fact almost forming a triangle from the spring of the arch to its point. At the one extremity of the structure, which is some little distance in the river, the



THE "NORIA"—TYPE OF WATER WHEEL USED BY THE CHINESE 1000 B. C.

building makes a turn parallel to the stream, and then widens sufficiently to contain one, two, or three, and occasionally four wheels, parallel to each other, and revolving with the current, each about 33 feet in diameter, and having a number of earthen vessels of three or four inches diameter and 20 inches long, placed at about 18 inches apart round the exterior rim of the wheel, which is formed of light small scantling, its greatest width being rather less than the diameter of the vessels attached to it, which, dipping a few inches into the water, are filled and forced

round by the current in succession, the open end foremost, until each in its turn reaches the top and then discharges its contents into a trough, which conveys the water from each wheel into the conduit of the aqueduct; and as the wheels are movable so as to elevate the axles by means of stones or beams of wood as the water increases, they can work equally well at any height of the river, the earthen vessels themselves giving a sufficient impetus without any other means, unless in some few places where the current happens to be weak, in which case six or eight fans of palm branches, each about 18 inches square, are added to the sides of the wheel to give the water more power upon it. There also exist parapet walls, or stone ramparts, in the river just above the several aqueducts. In general there is one of the former to each of the latter, and almost invariably between two mills on opposite banks a wall crosses the stream from side to side, with the exception of a passage left in the centre for boats to pass up and down. The object of these subaqueous walls [mistaken by Alexander the Great for means of defense against his irresistible legions] would appear to be entirely with a view to raise the water sufficiently at low seasons, to give it impetus as well as to afford a more abundant supply to the wheels and their effect is at times to create a fall in every part of their width, save the opening left for commerce, through which the water rushes with a moderately irregular surface."

This relic of antiquity is undoubtedly the origin of the "undershot," or vertical wheel, and we must come down many centuries before meeting any radical change in construction.

The populations of the Dark and Middle Ages were too busily engaged in fighting in this world and praying for salvation in the next to pay much attention to hydraulics or mechanics, although the old monks utilized the power of the streams on which they usually built their abbeys and priories to grind the grain for themselves and their neighbors, for the "Abbey Mill" is often quoted in old English records. When the writer was in England in 1850–51, he visited the ruins of Kirkstall Abbey, near Leeds in Yorkshire, built in 1152, and here saw the old artificial water-courses which had been used for the mill still in fair preservation, the foundations being intact. The application of the water had apparently been similar to that on the Euphrates ages ago. A low dam across the river Aire had diverted the current into a stone channel some 6 feet wide, which ran under the mill. Across this channel, with simple radial vanes dipping into the current, had probably been set a wooden wheel, the power from which was undoubtedly transferred to the millstones by an old "pin and trundle" gear, the precursor of all modern "bevel gears," not greatly dissimilar from the gearing

of the old mill in Pennsylvania which was used in the days of the Revolution to grind the corn for Washington's army at Valley Forge.

This same form of simple radial vanes was, until about 1750, as far as we can ascertain, the one in general use. It was applied not only in running streams, but in tide-ways when the rise and fall was sufficient to give available power. Nicholson says in his "Operative Mechanic" (1825) that they were not common in England, although they have been used in France since 1730. He says that they had been used to some extent on the Humber and the Severn and describes one erected on the banks of the Thames at East Greenwich by Mr. John Lloyd. The wheel of this mill was

"IT GROUND THE CORN FOR WASHINGTON'S ARMY AT VALLEY FORGE."

26 feet long, and 11 feet in diameter, with 32 "float boards." The wheel with apparatus weighed about 20 tons and was itself supported on a float so as to rise and fall with the tide, keeping the vanes or buckets sufficiently immersed at all times. The float on which it rested was hung on broad hinges, which filled and closed the passage underneath at high tide, the tide sometimes rising 20 feet. A water-way six feet wide was left at either end of the wheel, by which the pond behind it could be completely filled or emptied at high and low tide, when the change of level was so slight as to

A GUN FORGE OF REVOLUTIONARY DAYS—NEAR ROBESONIA, PA.

exert no effect upon the wheel. The circumference of this wheel was studded with pins at one end and a square vertical shaft reaching from the top to the bottom of the mill, carried on it a sleeve or collar with a "wallower" or lantern-wheel at either end. The distance between these wallowers was the same as the diameter of the wheel, and by raising and lowering this sleeve, the upper or lower wallower could be thrown in gear as the tide set in or out, thus causing the machinery to turn always in the same direction. This vertical shaft also moved freely up and down through the main gear, which distributed the power to the different sets of stones, as they, with the mill itself, all rested on a firm foundation. The head under which it was worked was usually from five to five and one-half feet.

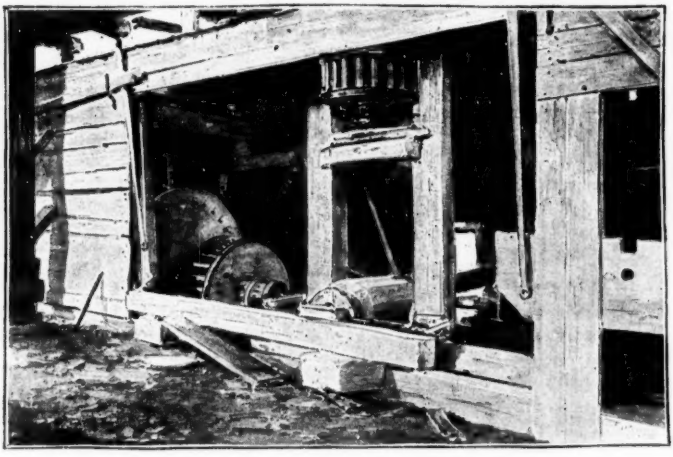
Nicholson gives credit to "the Americans" in this article for the contrivances for raising the heated meal to the cooling boxes and bolter. To America belongs also the credit of the application of water-power to sawing timber. One of these early mills erected by Brunel, for working wood at the Chatham Dockyard, is called the American saw-mill in his description of it in the "Papers of the Society of Royal Engineers." As shown in the illustration it still uses the old radial or "flutter-wheel," which is driven by the mere force of the current issuing from the sluice gate, and rushing through the flume. This familiar ratchet arrangement speaks for itself.

While the English still held to the old "sawyer" and "saw-pit," our forefathers, realizing that they could never clear the virgin forests of the New World with such slow devices, soon found that water-power would saw lumber as well as grind corn.

These simple float-boards wheels were often used under a vertical fall as well as in a horizontal "chute." Every New England boy has probably made a miniature one of shingles and set it up at the nearest spring in his father's "lot"; also, probably, with a model saw-mill attached to it, having a saw made from a broken watch spring!

We now come to a more scientific period. On May 3 and May 10, 1759, John Smeaton, the great English engineer, read two papers before the Royal Society in which he discussed the effect of "*Undershot Wheels*," and showed that the average power derived from them did not exceed 30 or 33 per cent. of that delivered by the water. On May 24 he read another paper on "*Overshot Wheels*," in which he demonstrated that double the effect, or 60 per

cent. of the gross power contained in it might be derived from the same water. The conclusions at which he arrived may be briefly stated to be: First, that the whole power of water was its weight, which was assumed to be 62½ lbs per cubic foot, multiplied by the height in feet of the fall, and that to obtain this power the water should be admitted to the wheel as quietly and as easily as possible; Second, that there was a great loss from friction and other causes in all "Impact" wheels moved by the velocity of the current; and, Third, that from his experiments, the most effective velocity of the circumference of an "Overshot wheel" was about three and one-half feet per second, corresponding to a delivery under a head



INTERIOR OF THE OLD GRIST MILL NEAR READING, PA.

of nineteen hundredths of a foot, or a sheet of water with an average head of thirty-eight hundredths of a foot or four and one-half inches thick. He states, however, that the velocity of the water when delivered to the wheel should rather exceed this, and "Glynn" assumes a depth of seven inches and three and one-half inches head as proper.

Other authorities have since assumed a somewhat higher velocity for circumference of wheel, usually about four and a quarter feet per second, and Mr. D. K. Clark is quoted in "Appleton's Cyclopedia of Applied Mechanics," as authority for the statement that the buckets should be three times the capacity of the volume

of water, or in other words, be but one-third full to produce the best effect, and that at a velocity of four feet per second such a wheel should consume one cubic foot of water per second for each foot of width. These wheels were of course "Bucket wheels," the interior circumference of the floats being filled up with a "shrouding." The floats were set almost tangentially, instead of radially, and the ends of the buckets so formed were closed up as seen in type "a" of the illustration showing the evolution of the bucket. This was soon found to be a wasteful form of bucket, as it discharged the water too soon, and the angular form "b" was adopted and has remained in general use in wooden wheels.

In England, however, where they were usually made of iron, a curved bucket of metal was introduced by Fairbairn, as shown in type "c." These curves have been varied by all sorts of "cycloidal" and epicycloidal forms, but as the principal object in this class of wheels was to admit sufficient water freely and hold it so long as possible, Fairbairn's bucket seems to be as good a form as any.

As economy of the water was more and more studied, objections were found to the Overshot wheel, viz., the water held in an arc of thirty degrees from the top of the circle, gave very little leverage, or effect, while its dead weight on the axle was a loss, the water had largely been discharged before reaching thirty degrees from the bottom, so that it was only effectual for one hundred and twenty degrees.

ORIGINAL FORM (a).

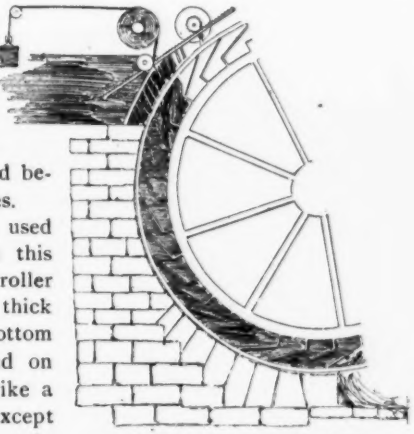
IMPROVED FORM (b).

THE FAIRBAIRN BUCKET (c).

This brought forward the "Breast wheel," which was made of greater diameter than the fall, and set so as to admit the water upon it, to use the old millwright's phrase derived from the face of a watch, "at from 10 to 11 o'clock." "Half past 10," a common height of delivery, was of course forty-five degrees below the summit of the wheel. The wheel was closely surrounded by a concentric "breast" of wood or stone for the lower quadrant on the same side, and sometimes even higher than the horizontal centre. This prevented the loss

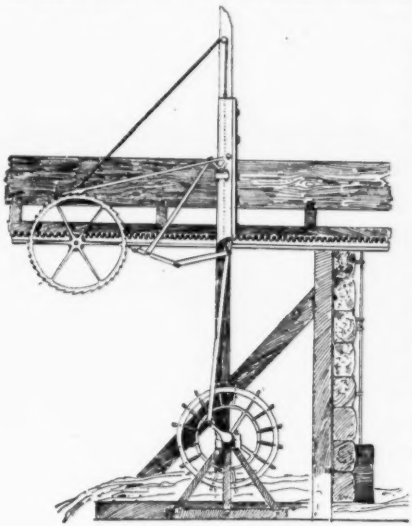
LEFT IN THE WAKE OF PROGRESS AND IMPROVEMENT.

of any water until it reached the bottom. The space above the top of the breast to the water level, was filled with guides or chutes set vertically to the buckets, and behind these were the gates.



LATEST FORM OF BREAST WHEEL.

The gate commonly used in the best practice in this country was called the "roller gate," made of a sheet of thick leather, nailed to the bottom of the chutes and wound on a roller at top, exactly like a common window shade, except that instead of the curtain lifting *up* the roller moved *down* and admitted the water over its top. This leather curtain lay directly upon the chutes and was supported by them, and no water could pass except such as went over it. The breast wheel increased the economy of effect to 75 per cent., and extreme instances are recorded of tests showing over 80 per cent., but 70 per cent. is high enough to take for an average of those in common use.



AMERICAN SAW-MILL.

The Fairbairn bucket noted above was from a wheel on the River Ayr. The wheel was fifty feet in diameter and ten and a half feet wide, and was estimated to give 120 horse power. Interesting examples of the old Overshot wheel are those of the mill near Reading, Pa., used to grind grain for the Patriot army, of

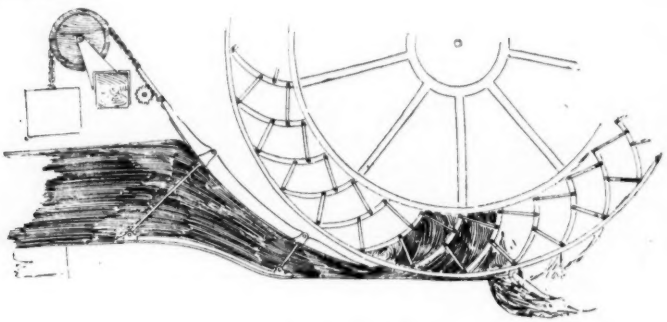
which the trundle gearing, for transmitting the power in a line of motion at right angles, has been described; and the Gun forge near Lebanon, Pa., also a relic of Revolutionary days.

Wheels of large diameter have been constructed in Wales and elsewhere, and an exceptionally large one, having a diameter of 76½ feet but only 2 feet wide, was built by Messrs. Donkin & Son of London and sent to Italy.

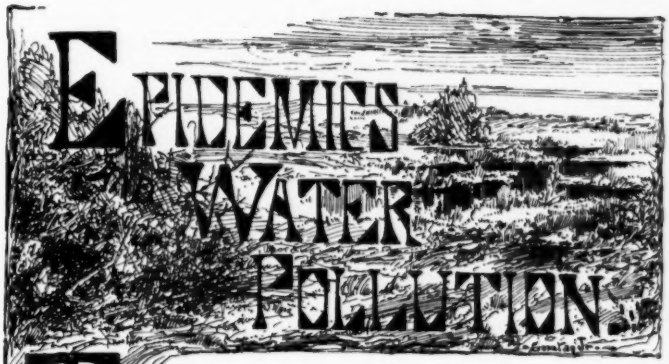
Let us now return for a moment to the subject of Impact wheels. The late General Poncelet, long chief of the *Ecole de Genie* at Metz, and with whom the writer served on the Mechanical Jury at the first International Exhibition in London, 1851, devised such a wheel of very light construction with curved buckets, entirely of metal, a cut of one of which erected by M. De Bergue on the River Loire, sixteen feet eight inches in diameter and thirty feet wide, was shown at the Institution of Civil Engineers.

The result as stated was not very economical, as with 2000 cubic feet of water per second, and a fall of six and a half feet it gave 180 horse power, or only twelve and six-tenths per cent.! This is undoubtedly a very unfavorable example of an Impact wheel, working a very large wheel with a very low head. The opposite extreme, of a very high head on a small wheel is illustrated by the Pelton wheel, which is very popular in mining districts of the Pacific Slope.

It is said to have given 88 per cent. of the power of the water used, a statement regarding the accuracy of which the writer is at least skeptical, as it far exceeds his knowledge of the results ever gained by any Impact wheel, and equals that of the very best turbines.



PONCELET'S UNDERSHOT WHEEL.



By George W. Rafter, C. E.

THE problem of maintaining purity in our water supplies may appear at first glance an easy one, but when studied in its application to the requirements of modern municipalities it is found to be of such difficulty as to still remain unsolved.

There is of old a principle of the common law, inherited by us from our English ancestors, to the effect that riparian owners have a right to drainage along the natural lines; and it is interesting to note how this view, coming to us from the Middle Ages, has gradually expanded until the general right of drainage has been held to be a prescriptive one, and not to drainage only, but to sewerage, as we use the term in modern times.

While the bulk of our people lived in isolated settlements and the necessary supply of potable water could be obtained from the ground by the medium of wells, there was no valid objection to the use of water courses for carrying away the various waste products which we now include in the term of sewage; but with the growth of cities and multiplication of industries, calling for increased use of water in every direction, supplies of ground water proved insufficient in most localities, and urban populations were compelled to seek more reliable supplies from large bodies on the surface. Thus the progressive growth of a public water supply is an interesting study, and it is finely illustrated by the case of the city of New York, where in one hundred and seventeen years there has been a gradual evolution from the well on the bank of the Collect in 1774 to the new aqueduct in 1891.

In the year 1774 no valid objection could be urged to the people

of the Croton Valley disposing of their wastes by way of the Croton River; and so long as the conditions remained substantially as they were at that time, no person was injured by the disposal of such wastes in the most convenient manner. But changed industrial conditions led to the development of the great city of New York, and consequently the further exercise of the right of drainage, so far as sending sewage or other pollution into the stream or its tributaries was concerned, not only interfered with the inherent rights of a large municipality to a pure water supply, but would actually lead, as we now understand the matter, to irreparable injury to the people of that municipality. Modern biological studies have enforced the proposition many times over that the germs of typhoid and many other diseases usually gain access to the human economy through the medium of drinking water.

So long as mankind looked upon disease as an infliction of Providence there could be no general conception of the danger arising from the contamination of a public water supply. This is finely illustrated by the conditions which exist to-day in many parts of India. Believing that the causation of disease is beyond their control, the natives refuse to accept any explanation of an epidemic of cholera other than that of a visitation from the gods. They see no objection to placing vaults where the contents drain into reservoirs from which water supplies are drawn, nor will they listen to the plain teachings of experience. The result is that where such conditions exist cholera is never absent. The unsanitary conditions produced by the Indian water tanks receiving quantities of drainage and other objectionable organic matter is intensified by the climatic conditions. In many localities the entire water supply must be stored through many months of drought, and by reason of the development of large quantities of infusorial and cryptogamic growth the waters become in the end disgustingly offensive.

This illustration will serve to enforce the moral that the preservation of the purity of water supplies, in India at any rate, will be a matter of popular education quite as much as engineering; and it is idle to conceal the fact that in the United States also one occasionally meets a little of the same spirit. The experience of the municipal authorities of Rochester, New York, will serve to indicate how difficult it is to preserve the purity of our public water supplies, and will strikingly enforce the proposition that such preservation depends very largely upon the creation of healthy public opinion.

The village of Springwater, New York, from seventy to eighty years old, with a population of about six hundred, is situated directly upon the inlet stream of Hemlock lake, the source of the domestic water supply of the city of Rochester. Its location in a deep valley far from the main lines of travel has tended to preserve a certain ruggedness of character among its people not often found at the present day. They are, moreover, like the average rural community in western New York, generally moral and religious and intend to do what is just and proper as between man and man. By reason of the isolation of the village the recent advances in knowledge regarding the cause of disease had previous to 1890 hardly penetrated to them. Their physicians even had not kept up with the times in this particular, and one of the three who practice there still denies the validity of the evidence showing bacteria to be a common cause of disease. The newspapers taken by the inhabitants are either religious, political, or literary in their character, and in consequence the people of the village have remained entirely without sanitary teaching. In such a community it follows as a matter of course that vaults are located in dangerous proximity to wells, and finally when the conditions became favorable soil saturation produced the inevitable result of an endemic of typhoid fever in the autumn of 1889.

Under the authority of the health laws of the State and of the city charter, the Executive Board of the city of Rochester took measures to prevent the spread of typhoid to that city. Inspectors were employed who, acting under the local board of health, disinfected and buried the dejections of the sick. Chemical and biological examinations of the waters of a number of the village wells were made, and several were found to be seriously contaminated, while in one of them the bacillus of typhoid was fully identified. The expense of this work of inspection, disinfection, and study, was paid by the city of Rochester as a part of its measures for protecting its public water supply; but in Springwater it appeared to many of the people a most unjustifiable proceeding that they should be subjected to any sort of sanitary regulation. Some even affirmed their right to cast the dejections of the typhoid patients directly into the stream, and the statement of the eminent biologists and chemists who made the determinations that the waters of the village wells were unsafe for use, was taken in some degree as a personal affront. The scientific side of the question made no impression upon them. Instead of treating the sudden appearance of more than twenty cases of

typhoid as a matter of grave import, not only to them but to the city of Rochester, a portion of whose public water supply drained through their yards, they looked upon the exercise of the authority conferred by law upon the Executive Board, as an arbitrary infringement of their personal rights, to be resented accordingly. This undoubtedly is the temper in which sanitary supervision when vigorously administered is at first received nearly everywhere. But there is a saving grace in our American communities which makes them far superior to the native East Indian. The intelligent discussion of a question of general interest has its legitimate educational effect ; and it is but justice to the good people of Springwater to state that now, after fifteen months have elapsed, a very fair proportion of the population admit and believe that there is a good deal of truth in the view that impure water and uncleanly surroundings are the frequent cause of disease. Some of the physicians have also adopted this view and are helping to build up a healthy local sentiment in regard to sanitary matters.

We need to enforce the principle, however, that there can be no natural right on the part of any human being to put into our streams the germs of typhoid. In reality the question of whether the stream is used at some point lower down as a public water supply is of no significance. So long as there is a possibility of even one human being drinking the water, no riparian owner has the natural right to drain typhoid into it, any more than he has the right to add strychnine or belladonna in such quantities as would make the water poisonous, nor can one by virtue of long use gain such a right.

The legal questions which are involved have been the subject of considerable discussion on the part of municipal authorities and others, and in view of the growing importance of a clear understanding of them, I will here cite some of the legal points involved, though it may be premised that what is stated must be taken as the views of an engineer interested in sanitary matters, rather than as one skilled in the law.

By the common law the right to do a thing which from the nature of the case could have been created by a grant, may be acquired by an individual through long continued and peaceable possession ; and such title is denominated " prescriptive," though the length of time required to give it validity varies in different States. In New York it has been fixed by the Statute of Limitations at twenty years, while in some other States the lapsing of

fifteen years suffices. In order to constitute a prescription in England in former times the enjoyment of the right prescribed for must have existed "time out of mind," but in modern times, not only there but in this country, definite periods are fixed by statute.

Angell in his "Treatise on the Law of Water Courses" has affirmed the principle of a prescriptive right to pollute water courses under certain circumstances. In administering sanitary regulations for the protection of the drainage areas whence public water supplies issue, one often meets the idea among both laity and professionals that rights of pollution enjoyed by the inhabitants before taking the stream for a public water supply, have become prescriptive, and that such rights cannot be debarred except by the payment of money or other valuable consideration.

Now the *sine qua non* for the observance of a common law is that the custom itself be good; and according to Blackstone the goodness of a custom depends upon its having been in vogue from a "time whereof the memory of man runneth not to the contrary." If any one can show the beginning of it, the custom is not good. It must, furthermore, have been continued, peaceable, acquiesced in, and must be reasonable. When such customs have been firmly established they are compulsory, but they must be consistent with each other. Moreover, Blackstone expressly says, that if a custom is not good it ought not to be longer used; and hence by implication a custom which in a different state of society may have become established as the basis of a maxim of the common law, must be abolished when proven bad, either by changed social, industrial or sanitary conditions, or by new developments in natural science. This is the only rational view, for otherwise, instead of embodying the perfection of human reason the law would become an effectual clog upon all human progress. It is also in accordance with that other sound doctrine of the common law which prohibits creating a nuisance to one's neighbor.

In the application of these fundamental principles to the question of sewerage and drainage, it is urged that practically all such privileges are recent. The time when the custom began may be readily defined by many. Again, it is unreasonable for one human being to turn the contents of vaults into streams from which others may take drinking water. The matter looked boldly in the face is so gross an injustice, as to need no argument to show its unreason-

ableness. Likewise it is inconsistent for human beings to pollute that which for their own uses should remain unpolluted. Understanding the serious effects of such pollution as we now do the custom of turning sewage into any stream which is the source of a public water supply, is so utterly bad as to be worthy only of immediate abatement, even though the custom has been maintained from time immemorial.

The tendency of American law as indicated by many decisions is on the whole in the direction of an abridgement of the right to pollute by reason of adverse possession ; although Kent says that if such occupation of a stream as corrupted it in quality has existed for so long a time as to raise the presumption of a grant or title by prescription, those having lands lying below must take the stream subject to such adverse right. But this view will undoubtedly be modified as such cases assume greater importance in this country, for the doctrine of adverse possession in its first inception applied to land only, and its later application to rights in natural water courses is merely an extension of the doctrine by analogy.

Some advanced sanitarians have held that the drainage area from which a public supply of surface water is drawn should be entirely uninhabited, and have advocated the buying-up and laying waste of the water shed, and one English city acting on this view has purchased the lands from which its supply is drawn.

It appears to me, however, that this view is largely erroneous. What is wanted is not that the water supplies for our communities should come from wild land, but that it should come from areas on which no unsanitary conditions prevail, and this may be attained from moderately populated cultivated areas nearly as easily as from uncultivated, provided the requisite power of sanitary supervision is granted. State legislatures should recognize the fact that municipalities are deserving of the fullest protection for their public water supplies. In New York State this view has been in some sort accepted, and in 1885, a general law was enacted by the terms of which the State Board of Health may make regulations for the sanitary protection of any public water supply in the State. The rules and regulations so made, before becoming operative must receive the approval of the county judges of the counties in which they are to be applied, and their enforcement is left to the local boards of health of the township in which the nuisance or unsanitary condition complained of is located. All this renders the machinery rather cumbersome, and while the law marks a great ad-

vance upon anything previously enacted it is still susceptible of considerable improvement. A number of the municipalities of the State are not situated in the county from which their water supplies are drawn, and in such cases the county judges as elective officers are unlikely to approve of rules and regulations which seriously discommode their constituents. The enforcement of these rules by the local boards of health, such enforcements being from their point of view of benefit only to the people of another county, has also its disadvantages.

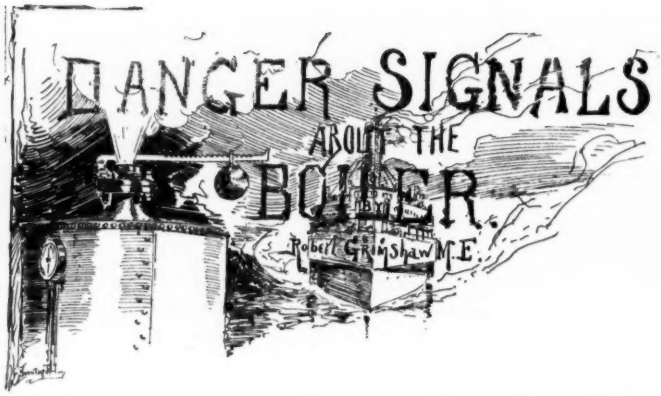
What is needed in the way of additional legislation, is the power on the part of the municipality whose interests are to be protected to present to a competent sanitary authority, plans for the sanitary improvement of premises, by moving barns, pig-stys, vaults, and other out-buildings, changing the channels of water courses and making needed alterations to prevent the contamination of down-flowing streams. The central authority having granted permission to do this the law should be made strong enough to insure its prompt and certain accomplishment; but the expense of the changes made should, of course, be borne by the city whose water supply is protected.

Herein lies the principle to be recognized and which should govern this whole matter of sanitary supervision of water sheds. The cities should have the right to fully protect the health of their people, including the right of entry on premises, and the inhabitants of the water sheds should equally be paid for the actual expense of removal of buildings and change of water courses. And while the inhabitants are as a matter of justice entitled to compensation for actual changes, there should be no uncertainty as to the right of the interested municipality to demand the cessation of all pollution that can be abated (without change of existing arrangements) and impose serious penalties for continuance. There is no inherent right to pollute.

In conclusion the points which I wish to enforce in this paper are:

(1) There is not only no natural right to pollute a water course but there can be from the nature of the case no such thing as an acquired right to cause such pollution.

(2) The maintaining of the purity of our water supplies will depend chiefly upon the creation of a healthy public sentiment, by the dissemination of sound sanitary information and on the strengthening of sanitary administration by advances in legislation.



IT is strange that manufacturers and business men who are shrewd observers of signs in the heavens, in the political horizon, in the money market and in the business world ; who are also competent and prompt to take advantage of signs of impending illness, should be so blind to equally important danger signs ; namely, those about their steam plant. Some of the signs which they do study and regard, and by which they shape their actions and investments, are apparently trivial ; many of those which refer to the weather and to forthcoming calamity, absolutely so, being utterly unfounded either in theory or in fact. Still, the belief in "signs" is wide-spread, almost universal, having extended down the stream of time for centuries, now growing, now abating. Far be it from me to discredit even weather-signs, however little credence I place in omens pure and simple ; still further, then, be it from me to remain unmindful of certain danger signs about the power plant ; for neglect of such signs has so many a time proved costly, even fatal, that no one has a right to scout at them nor to pass them by thinking that the danger is too far ahead for any immediate worriment or prevention.

Some of these signs are so plain and obtrusive that "he who reads may run." Others are less prominent; but it should pay power users to know what they are and what they mean, and to be on the look-out for all of them, whether conspicuous or not.

Among the dangers which menace a boiler are explosion, corrosion, leakage, burning, and leaky or dilapidated front or setting. Of course some of these lead up to others—as corrosion or burning

indirectly causes explosion. Some simply mean waste of fuel, or diminished steaming capacity—evils, too, and to be prevented. Others herald danger to life and limb as well as wreckage of property.

The boiler owner often unconsciously imitates Dibdin's sweet little cherub who sits up aloft; but there should be—there must be—another cherub, smaller and sweeter, who sits up further aloft and watches o'er the life of the poor power user himself; for it seems mere dumb luck that more boiler owners and innocent victims are not blown up higher than war-prices. It is not their own watchfulness nor their own cautiousness that keeps them safe and sound. It may be their insurance policies.

I have gone into manufacturing establishments time and time again about noon time and heard the safety valve blowing off with a roar like the rush of falling waters. Such a sound, while desirable in that it is a token that the valve is operative, is also a sign that the engineer or the fireman is wasting fuel and risking a catastrophe by not banking his fires at the proper time or in due manner. The moment may come when the valve will not lift and the pressure will accumulate after stopping time, until there will be a good chance for the fire department and the coroner. Such a continuous roar at times when the establishment is shut down is a danger sign and should not be allowed to manifest itself more than "once hand-running."

We will suppose that the establishment is equipped (as it should be) with a recording gauge, and that the boiler owner comes down in the morning and finds that the pressure had risen say by 11 o'clock the preceding night to working limits. That may mean that the heat of the masonry of the setting has been given out after the fires have been banked or drawn; and with only a little water in the shell there has been a good chance for a "blow-up." A brick-set boiler that runs night and day for six days and shuts down for Sunday is very apt to do just that very thing. Some Sunday it may do it once too often.

If when the boiler is under steam the safety valve lever is lifted with cord or pole and the familiar roar of escaping steam is not heard, it is a sign that the valve is completely inoperative; a danger sign that you, if a steam boiler owner, should act on as quickly as possible. See for yourself that your fireman does so lift the lever; ascertain for yourself that the valve is not stuck on its seat.

Go down some time and see that when the steam supply valve is

shut off and the boiler is under steam, the safety-valve can discharge all the steam that can be made by the best fire the grate will hold. If it does not without the pressure gauge rising beyond the point at which the safety-valve is loaded to blow off, it is a danger sign which you should be prompt to recognize by ordering the fires immediately drawn for that occasion and not lighted again until there is either an additional safety valve or considerable overhauling of the old one, or both.

Leaks about seams or plates between rivet holes—particularly the latter—are danger signs. The former are not infallible—they may simply indicate bad caulking; but their discovery should be promptly followed by inspection and remedy. As a fence in Georgia is not a legal fence unless it is "horse high, bull strong, and pig tight," so a boiler is neither a legal nor a safe boiler unless it is tight as well as merely apparently strong. These leaks, no matter how trifling, may be the starting points of dangerous cracks —particularly in steel boilers. If they never do any other harm than ruin the non-conducting covering (which I assume every common-sense boiler owner to have provided) they work danger to property. If they do not bring down the whole covering (as is possible with some of the plastic kinds) they lessen its non-conductive qualities. Every leak is a danger sign. Investigate it; see what it points to, and act promptly.

If leaks are of red water instead of clear; or if they are indicated by white or gray deposits, that is a sign that the water is impregnated with iron in the first case, and with lime, salt or magnesia in the second; and no such water should be fed into a boiler. That is a sign that unless you purify the feed before it goes into the generator, there will be loss of fuel and lowering of steaming capacity, by reason of scale-formation; this may lead to burned plates which will have to be replaced unless they cause an explosion, in which case not only the entire boiler but the proprietor may have to be replaced.

If when a boiler is opened out the metal does not show clean and neat, it is a sign that the feed is bad and that you need a purifier,—not merely a dose of medicine, but a mechanical appliance in which whatever impurities are separated shall be deposited. Doses may loosen scale, may largely prevent its formation, but the stuff which forms scale should never be allowed to enter the boiler. A man who swallowed hair and cotton waste because he could take purges or emetics to get rid of them would be considered a

forty horse-power jackass. But the man who lets impurities get into his boiler, and then tries to purge them out, is doing the same sort of thing, only worse—he is endangering other people's lives as well as his own.

If the water level in the gauge-glass races up and down it is a sign that the water in the boiler is surging, and this ought to be stopped. Sometimes that calls for feed purification, sometimes for stoppage of local excessive heating; sometimes for blowing off; again, for prevention of animal oil from the engine cylinder entering the boiler by way of the exhaust feed-heater.

If when the engine or some heavy steam-consuming apparatus is opened out the water in the gauge suddenly drops down out of sight, it is usually a sign of insufficient steam room, or rather insufficient disengaging surface at the water level; and this may generally be remedied by carrying the water lower so as to bring the level nearer the horizontal diameter of the shell or drum. There are cases, however, where there is insufficient disengaging surface caused by carrying the water below the horizontal diameter of the drum for the purpose of giving plenty of steam room; and in such case the remedy is usually to carry it higher, so that the bubbles of steam shall have a chance to rise and disengage without carrying the water with them.

If on looking into the furnace or fire-box you see a depression in the crown sheet; that is, a bulging down from above, that is a sign that the mud or scale above the spot thus depressed has prevented the water from carrying off the heat of the fire, and has thus allowed the sheet to get red hot, and to come down by reason of the pressure. What has happened once may happen again. The same spot may get heated again and come down all the way, and if such a thing happened, the community would know of it. Sometimes the hot spots come down all the way the first time.

If on going into the boiler and rapping the braces (supposing there are rod-braces) any of them sound loose and rattly, that is a sign that they have stretched or that the surfaces which they connect have stretched, or that adjacent surfaces have moved out of place. It usually shows that there is undue strain on the adjacent stays; and the loose ones should be tightened up so that the stress shall be divided up evenly, as originally intended.

I say "on going into the boiler." I assume that you take enough interest either to go in yourself once in a while, or to see to it that some one thoroughly in your confidence goes in for you and

reports to you, independently of your engine runner or fireman. Ex-Mayor Cooper, of New York, a millionaire and a member of "the four hundred," goes into his boilers, lamp in hand, and sees for himself that things are right. No one ever accused him of doing anything for effect; and I think that he is rather inclined to taking things easy and to have things as neat and nice about him as he can. But when it comes to the boilers he wants to know about them himself; particularly about their inside condition. Too much hangs on that to leave it to a deputy, no matter how capable, no matter how competent.

If the finger of your steam-gauge vibrates with each stroke of your engine, that is usually a sign that there is not enough steam room. It may indicate very sharp cut-off at the engine, but there is nothing dangerous or undesirable about that.

If on looking into the combustion chamber you see blue flames streaming from cracks in the brick-work, that is usually a sign that excess of air is getting at the fire from above, rather than coming through the grate as all air should come, if possible. It is in this usually a sign of waste of fuel and lessened steaming capacity; but independently of this it shows that the brick-work is in bad condition; and when you find that out you should take the first opportunity of inspecting and the first of repairing it.

If you find the boiler blowing off one minute and steam running down the next, it is a sign that you have not enough boiler capacity, or that the demands of your establishment for steam are too irregular and capricious, or that the fuel is bad, or that the fireman is incompetent. All these may be the case.

If you find the plates scored at the seams by the caulking-tool, it is a sign that some day you may have a first-class private explosion.

If the fireman heaps coal on the middle of the grate of a boiler of locomotive type and leaves uncovered spaces next the water leg, it is a sign that he ought to be discharged as incompetent; and that if the practice is continued, there will be a cracked fire-box some day, where the cold air from the ash-pit strikes the hot plates. (This is particularly the case where the fire box is of steel.)

If you see great volumes of black smoke come out of your stack every now and then, it is a sign that your stoker is firing up and that he don't know his business.

If a plate rings clear and sharp under the hammer it is a sign that it is in good condition considered as a plate. If it sounds dead

and flat it is a sign of burning, or of cracking, or of its being caked thick with mud or scale.

If your gauge-glass is half filled with sediment it is a sign first that the feed-water is foul, and second that the glass should be taken out and swabbed, and the passages in the fitting bored out clean and full size, by a steel rod. Otherwise the gauge-glass will become utterly useless, and a lying gauge is worse than none at all.

If a boiler which has been used to giving off steam that shows white when escaping in a jet, commences to "show blue" at the jet, it is a sign that superheating has been taking place; and while superheating is desirable when regular, in this case it probably means (particularly if the usual demand for steam is being made) that the water-level has been allowed to get dangerously low, and that there may be an item under the head of "Casualties" in the newspapers.

There are more "signs" which the boiler owner ought to look out for as danger-signals, and as indications of great waste of fuel and wear and tear of the boiler. The cautious and humane boiler owner should have a pressure recording and alarm-gauge in his office to show any sudden or undesirable increase of pressure; to act as a check upon the fireman and watchman at all times. But while every steam-plant should have such a gauge, the possession of this automatic watchman should in no wise make the boiler owner neglect the duty which he owes to himself, to his employés, and to the community—that of personal inspection of the boilers, inside and out, at frequent and unexpected times.

"Oh!" says the average boiler owner who reads these lines, or to whom you mention them, "my boiler is insured. I expect the proper officials and employés of the boiler insuring or accident insurance company in which I hold a policy, to keep their eye on it and to let me know. They have a direct money interest in its not exploding, and if it gives the least signs of letting go they will be only too willing to tell me that it must be overhauled and repaired at my expense, not theirs. Many a boiler owner—perhaps myself among the number—would let a little thing go which the insurance company would insist on being properly fixed up as good as new, at once."

"Consistency, thou art a jewel!" You, brother boiler owner, are probably insured against fire and carry a good "straight" life insurance policy, and another covering accidents. Do you, because you

hold policies which indemnify you or your "heirs, successors, administrators and assigns," deliberately ignore all precautions against fire, pneumonia, or smoking in a powder magazine? Or do you see to it that the grate fire has a fender put before it; that you wear an overcoat when the winds are piercing; and that you extinguish your cigar even before opening a ten-pound powder keg?

Of course the insurance companies have a direct moneyed interest in your boiler not exploding; and of course, equally, they try to have them properly inspected and intelligently reported on. Still, they are not in business for their health, but to make money. They cannot afford to make daily or even weekly inspections of each boiler insured. It is cheaper for them to have an occasional explosion for which they have to pay—or rather for which the boiler owners who are insured pay—than to have excessive pay rolls. In fact, an occasional explosion paid for by the company is a good advertisement and business bringer, just as the death of a prominent policy holder in a life insurance company can be made to pay for itself over and over again.

It is the boiler owner's privilege, as well as his duty, to supplement the boiler inspector's and boiler insurance company's work by keeping his own eyes and ears open and seeing personally that his boiler is safe and sound—just as he assures himself by occasional personal inspection that his cash and merchandise are safe and on hand as well as merely accounted for. It no more requires a skilled engineer to do this than a skilled accountant to do the other.

THE RAPID TRANSIT PROBLEM IN NEW YORK.

By T. Graham Gribble, C. E.

I.

THE commissioners who have been deliberating for the last three months upon the various schemes proposed for handling the traffic of New York have had a very onerous and responsible task. They have listened to descriptions of about two dozen different projects, and have extended the same courtesy to all the proposers. At the same time they have decidedly though politely insisted upon keeping to the point, and Chairman Steinway has frequently been compelled to deny a hearing to those whose communications could not be brought into the category either of Routes or Methods of Construction.

The public sessions have not been without their humorous side, as shown in the reports of some of the daily newspapers; but it must not be thought that even the unpractical schemes have been valueless. Everything that stimulates thought, especially that which has cost the thinker much time and labor, is of value both to himself and to the matter in hand. There have been some schemes before the commission which do not appear to disinterested observers as having reached the practical stage, yet nevertheless display so much ingenuity that it is probable they will eventually find a useful and profitable field.

When we say the commissioners have had an onerous task we only speak of what is apparent from the public sessions, but the greatest labor by far must have been in the executive sessions of the board, when endeavoring to come to a conclusion upon the best means of rapidly relieving the present congestion of traffic and of providing for the city's future development.

The responsibility is one of the greatest that could devolve upon a citizen. The decision will affect the city's growth and the character of its upbuilding for all time.

It is no mean city for which the commission is empowered to act. To all appearance New York is about to become the next Queen City of the world.

The trend of empire has been westward since the world has had a history. The nucleus of civilization has moved from Baby-

lon to Alexandria, from Alexandria to Rome, from Rome to London. We are now on the threshold of the transition from London to New York. Indications of the coming primacy of the United States amongst the civilized powers of the earth are plainly to be seen in the cosmopolitan character of the nation; the establishment in the immediate future of a navy and a mercantile marine worthy of the American flag, and last, but greatest, the development of intercontinental railroad communication.

New York City is and will remain the eastern portal of this continent. San Francisco is its west gate and has a noble future. Like new pillars of Hercules, brought into touch by rail and telegraph they will receive and transmit from their broad estuaries the chief burden of a mighty nation's commerce.

As compared with the earlier history of nations, changes take place to-day with startling rapidity. The city is face to face with a problem which has much more in it than the relief of the congested traffic upon the Manhattan railway cars. The island itself, capable of containing between two and three millions, is but a small portion of the city which is to be.

If we describe from the City Hall as a centre a circle having a radius of fifteen miles we shall about include the area which must shortly be brought into vital and close connection. The question of consolidation of the various municipal governments is a secondary one. Differences of constitution both of counties and states may delay such arrangements, but the exigencies of intercommunication cannot afford to wait for them. The gigantic schemes for bridging and tunnelling these estuaries which have either passed the Legislature or are referred by it to committees are all of them proofs that the inhabitants of the group of cities surrounding this island are about to incorporate themselves into a greater New York by an informal bond of union.

Every one of these links between the cities will, if judiciously planned, create its own traffic. The Brooklyn Bridge carried nine millions in 1884–85. In 1889–90 it carried, with the same two tracks, thirty-five millions. But the ferries are running as frequently and full as ever. Jersey City is more isolated from New York than Brooklyn was before the building of the bridge, but only awaits a tunnel or bridge to join hands both with Newark and New York, and from the stimulus thence derived to spread out on either hand.

The task of the commissioners is happily for them limited to

the present boundaries of the city. They cannot avoid taking an outlook upon the changes which are at our doors, but the schemes for external communication are to be settled at Albany.

To judge from the marked interest displayed by the commissioners in any scheme which affected the existing means of transit, it would seem as if they intended to make a point of improving what we have already, and this would be nothing more than practical common-sense. It will not by any means suffice, but it will afford in a small way immediate help. The New York Central and the Manhattan railways, together with the various horse-car systems, are our existing means of transit, and represent three classes of business which are at present kept distinct by the difference both of the requirements of travel and the means provided for it; but they are all in great need of improvement. The New York Central needs a connection with South Ferry. The Manhattan railway requires increased working capacity and extensions to the suburbs. The surface systems need mechanical traction. But when all this is done, the congestion will be as great or greater than ever. Even with normal development, the improvements just detailed would not be completed before the traffic would be correspondingly increased, but if in addition fresh external communications are provided by means of tunnels or bridges, every one of them bringing to and fro its thirty millions per annum to circulate through the city by day and night, all available means of internal transit will thereby receive a fresh burden. The capacity of the existing railways is limited and some of it is more adapted to external travel. The present congestion is between South Ferry and Harlem, along the arterial lines of the city. It is consequently of the first importance to provide suitable means for the people to get about within the city itself.

Schemes which are conceived with the object of rivalling the New York Central Railway in providing a high speed transit to the outlying residential districts of the Hudson River, are not so urgently required as internal transit at a speed about equal to that of the express trains on the elevated road. It is moreover evident that no single avenue can supply the present and prospective need. It becomes, therefore, an essential feature in a project that it should possess adaptability, without prohibitive cost or excessive time in construction, to any and every one of the city's avenues.

It is a weak point about many of the proposals which have been suggested during the last few years that they attempt too much,

thus evidencing an inability on the promoter's part to grasp the magnitude and diversity of the factors in the problem. Thus, in a former subway railway scheme, adapted as it was entirely for short-haul internal city traffic with a constant service, it was proposed also to operate ordinary freight trains. On the other hand, in the deep tunnel schemes it is proposed to handle by means of way-stations and elevators the same class of short-haul traffic as is now taken on the elevated road; an equally decided mistake. The fact is that New York cannot go her rounds on one horse; she needs a good, sturdy draft horse, a handy, serviceable roadster, and a thoroughbred high trotter; and we will begin with the racer.

It is easier to dilate upon the benefit to be derived from the extension of the tracks of the New York Central Railway to Battery Place than to point out how it is to be effected. The difficulty of extending any line from a large terminal depot in a city, arises in the first place from the fact that the arrival and departure platforms are at some distance from one another, and for a four track extension the two down-town trains would have to come in as at present on the arrival platform and depart from it also. The up-town lines would have to come into the departure platform and depart from it. If the traffic were heavy this would entail a reorganization of the marshalling system.

When in addition to this the terminal depot is on the street level and the tracks cannot be continued thus, there arises the still greater difficulty of grade. To prolong the tracks in a tunnel would require the dipping down of the grade about half a mile north of 42d Street so as to run under the street at the depot, and this would entail at the same time a deviation of alignment for which a greater width of the street would have to be occupied.

In the practical working of such an arrangement it is found that the spur track trains hamper the running of the main line trains. It is not generally known that the Great Eastern Railway station, one of the finest metropolitan terminal depots in England, was built on the low level entirely to form a connection with the Metropolitan Underground Railway. The Act of Parliament permitted them to build on the high level which would have enabled them to put in a level gradient, but solely for the purpose of this connection they dropped down by means of expensive retaining walls and heavy grades. The connection with the underground railway was operated by through trains only to be definitely and forever abandoned. The underground railway handles one class of

business and the Great Eastern Railway another. An exchange platform by means of a short covered way was substituted and found to be the only suitable connection between them.

The New York Central Railroad has already almost reached the capacity of its present four track tunnel, long trains are being run all day long on very close headway ; and the block system limits or *should limit* the headway upon which the trains are permitted to run. It is a *distance* headway ; not merely a *time* headway, which is the essential feature of the block system. To attempt to squeeze in a 2½ minute service of way trains from Harlem to South Ferry between the present running, would throw everything into confusion. The way trains now being operated between the Grand Central station and Harlem do not handle the local traffic, neither do they attempt to do it, for the time table is arranged on one hour headway. Local travel will always decline to be congested into trunk lines if it can find vent some other way, and it goes either to the elevated railway or the horse car. The way-train stations are too far apart and the trains too infrequent to make them the natural medium for local travel. The great value of a through connection at the Grand Central station to South Ferry, is to improve upon the shuttle train and Third Avenue connection, which now takes from twenty-five to thirty-five minutes, according to circumstances, and also entails considerable stair-exercise. This distance of four miles should be compassed in from six to twelve minutes, so that the passenger coming from Tarrytown to Wall Street every morning should be able to do it well within the hour.

It will be shown later on that either with the Austin-Corbin or the Greathead system a suitable connection could be made in the form of a "three way-link" to unite Brooklyn, Jersey City, South Ferry and the Grand Central Depot. Elevators of large capacity would be provided at all the depots and the traveller would be able to make easy connection with or without baggage from any one railway to another. All the railways would be so much benefited that such a scheme might appropriately be promoted as a union railway company guaranteed conjointly by all the interested companies.

Great as this benefit would be, it is hardly necessary to show further that it would not be in any sense a solution of the problem of internal city transit. Even technical journals have spoken of it as such, but a cursory examination of the character of the city travel and its present congestion should be enough to demonstrate

the fact that neither the elevated nor horse cars would be one whit less jammed after such a connection was made than at the present time.

Following up our equine simile, we now come to the roadster; that is the means of internal communication within the island, and commence with the proposed improvement upon the elevated railways.

The four double track railways composing the Manhattan railway system have been an immeasurable benefit to the city. They have been the principal means of the development of the northern end of the island. They enable business men to reach their stores and offices in a reasonable time, which no surface line could effect with safety however it might be operated. Twenty years have elapsed since they were projected, and one is astonished at the boldness of the capitalists and the engineers who could embark upon so novel an enterprise and at the toleration of the public in permitting the engine just outside their windows. It is held by some, possibly by many, that the elevated system is still the only solution of the rapid transit question.

The public certainly do not wish to see any more of their avenues occupied by these unsightly erections and would welcome almost any other solution in preference. The Manhattan Railway Co. has not applied for fresh avenues, but it asks for several extensions at Harlem and everybody expects them to be granted. This system is too great a benefactor to the city to be needlessly hindered in any reasonable attempt to increase its capacity, but we have yet to see the figures upon which the company has based its application, especially with reference to the manner in which they propose to handle the fresh traffic which is to come upon the down-town section of their lines.

The demand of the company for two fresh tracks on Battery Park is the most reasonable of any of their requests. They do not propose to put in more columns in the park, and in point of effect, when the work was completed which they have indicated upon their plans, the public would hardly know the difference in the appearance of the structure. The assistance to the operation of the western line would be great. At present the traffic on the four tracks of the Sixth and Ninth avenues is *wire-drawn* into two tracks from South Ferry to Battery Place, necessitating the stoppage of a great portion of the traffic at Rector Street. The structure on this short length is more substantial than any other part of the

system ; the columns are in quadruple and the bridge work composed of plate girders. It is proposed to surmount the present columns with cross girders 41 feet wide, overhanging the columns sufficiently to enable the new tracks to be laid on plate girders attached to the overhanging portion. It will have a somewhat aerial sensation to be travelling thus, bracketed out upon a serpentine curve, but it could be made as safe as any of the rest of the line. The most particular point to be sure of would be the foundation of the columns. The engines are already double the weight of the first

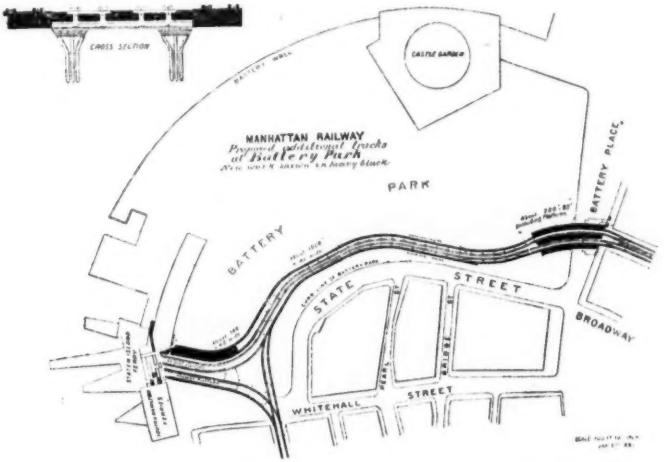
MAP OF NEW YORK CITY AND VICINITY.

ones, and where there are four tracks upon the columns the question is whether there is enough bearing surface upon the sand foundation to carry the load.

It is remarkable to what an extent the public travel by faith, principally because they argue that railway companies cannot afford to kill people, but it would be some additional comfort to know that all such alterations upon existing structures were referred to a responsible engineering authority other than the railway com-

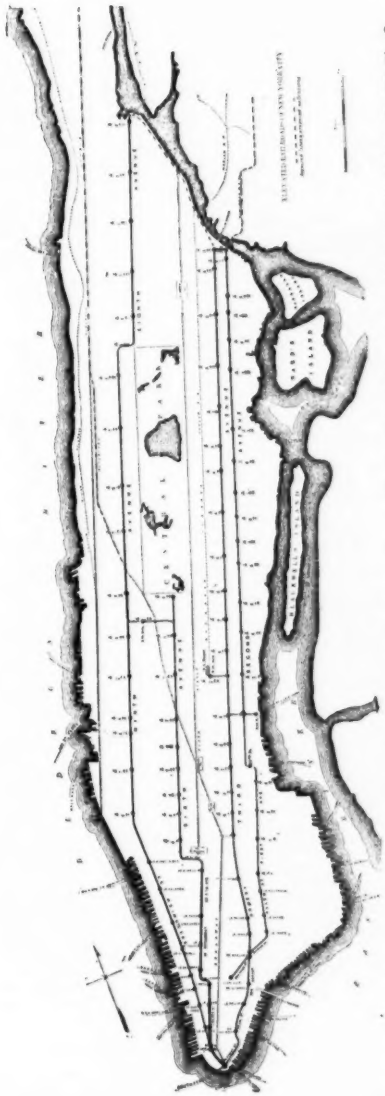
pany, such as the State engineer, before permission was granted. The design for these alterations might be misunderstood. It looks on the cross section as if the central tracks were in their actual position, whereas they are at present directly over the columns with a third track in between them. These tracks have therefore to be shifted in order to perform the alteration.

Furthermore, the plate girders carrying the present tracks meet over the shallow cross girders, and in order to make room for the new wide and deep cross girder they would have to be shortened. All this means a practical reconstruction of the superstructure and a suspension of the traffic. In addition to this the footways which are not shown on the cross section will cause the overhang to be



about six feet more than is indicated. It will be a very top-heavy looking structure when finished. A piece of work that might well make the unsophisticated foreigner arriving at Castle Garden pause and consider before he uses it.

The natural method from an engineering point of view would have been to put in fresh columns about six or eight feet outside the present ones, and it is absurd to speak of them as interfering with the comfort and convenience of the people using the park. If the company had been allowed to erect one or two sample columns to show what it would be, there would not have been so much hysterical outcry against it.



Not one person less would enjoy the Battery Park for those columns, neither would he have any less benefit out of it. This is a case in which the company should be allowed to make a reasonable improvement to the handling of their business and carry it out in a proper manner.

As regards the extension of the Manhattan railway to the northward, the case is different. The aim of the company is to get more traffic, but the question is how they are going to handle it.

If they can serve the public thereby, by all means let them extend to Albany or Chicago; but one would like to know just what they are going to do with Morrisania and Washington Heights' present and future population, when they have "corralled" them into the cars.

They have just acquired the Suburban Rapid Transit Co.'s road, which provides the east side lines with a feeder into the new district of Morrisania. They are applying for power from the Rapid Transit Commission to construct a loop along the south bank of Harlem River, which will make the

system into a belt line and feed both east and west lines with cross-town traffic. They are appiying further for an extension of the Ninth Avenue line along the Boulevard, into the new and rapidly growing suburb of Washington Heights, which will bring a great increase of travel upon the down-town sections of the west side lines.

It is a matter of paramount importance to know how they propose to handle these accessions of travel *safely* and *comfortably*.

They have already exceeded their carrying capacity, and transport passengers huddled together in a manner scarcely fit for sheep or oxen. The attempts to increase the original capacity have been confined hitherto to strengthening the structure and increasing the weight of the locomotives. This process has also reached its limit.

They cannot take down the light structures and replace them. They might insert intermediate columns and girders, but it would be sheer patchwork with doubtful results. Neither can they put columns in the middle of the street. But greater capacity they must have, by some means or other, to carry the passengers they get now without attempting more.

It is easy to say they will put in a third track here or there to run express trains, but in a matter of this magnitude it would appear to be the natural course for the custodians of the public safety to pronounce upon the safe capacity of the existing structure, and to take means for keeping the travel within that limit. It would be by no means superfluous to include the precaution of a periodic inspection of the riveting.

A costly operation was carried out after the line had been in operation some years upon the Third Avenue, by duplicating the web members in the original Warren-girders, and so forming them into lattice-girders. Even if there were a surplus of strength in the original chords, it is more than doubtful whether any gain was effected by the addition. It would be interesting to know whether the deflections were registered before and after the alterations.

The locomotive weights have been increased from 13.4 to 21 tons total, and from 8.5 to 14.1 tons on the drivers.

The vibrations of the structure are now greater in many places than ordinary riveting will stand, so that heavier locomotives ought not to be thought of.

Suggestions have been made for a change of motive power, either to cable or electric traction, in order to use lighter motors. Experiments were conducted by Mr. Lincoln Moss in February

1889, to show the relative cost of electric and steam traction upon the Ninth Avenue line, and the results, which were very adverse to electricity, were published with a discussion (somewhat qualifying the deductions of the paper) in the transactions of the American Society of Civil Engineers.

An ordinary steam locomotive was run in competition with a Daft electric motor, the trains being composed of empty cars. The total cost of running by electricity is computed by Mr. Moss as four times that of steam. The most disparaging element is the item for depreciation and repairs of plant. In the case of steam his figures are $24,472, but for electric plant $385,530. We know that the burning out of armatures and switchboards is still a skeleton in the cupboard, but we may certainly hope for some better showing than this. Setting aside the figures for the total cost, and merely taking the comparison of the cost of fuel, Mr. Moss estimates for steam $90,914, and for electricity $107,583, or 18 per cent. excess.

That electric railroads can be operated at a profit can hardly be doubted in the face of the bulk of capital which is being poured into them, but there is considerable room for cheapening them. The most recent statistics on comparative costs of electricity, horse traction and cable traction, are those of General Manager McCarty of the Kansas City Metropolitan Street Ry. Co., who finds that electric traction on the overhead system costs about as much as horse traction, and cable traction considerably less. There is, however, a further difficulty in the application of electricity to long hauls and heavy work; that the power required at the generator increases more rapidly than the increase of work.

A comparison was instituted by Mr T. C. Clarke between the cost of operating by cable upon the Brooklyn Bridge, and by steam upon the Manhattan, meeting with the following results:

	Manhattan.	Brooklyn Bridge.
Total cost per passenger mile...	2.793 cents.	1.523 cents.
Total cost per train mile.....	61.89 "	45.84 "
Cost of motive power alone per passenger mile.....	1.169 "	0.267 "
Cost of motive power alone per train mile.....	25.20 "	8.000 "

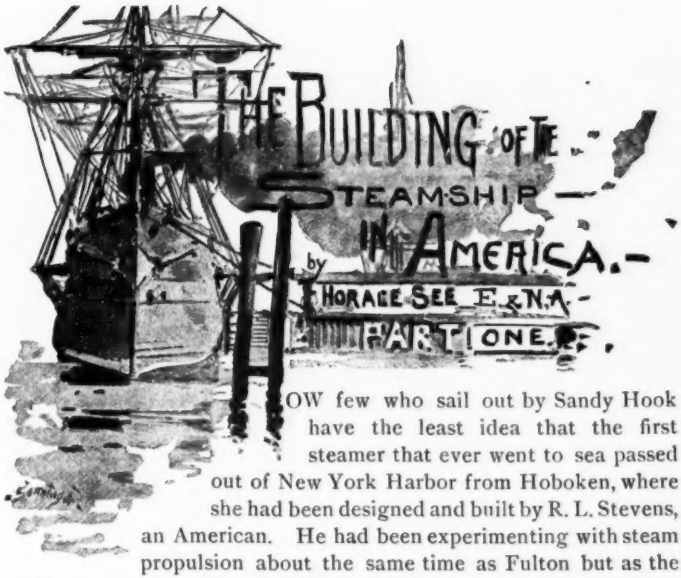
The cable-cars appear to be lighter, and there is no engine, so that probably the figures per ton-mile would not show so great a divergence, but there would still remain an excellent showing for the cable. There would be, however, considerable difficulty in

applying the cable to a structure not originally designed for it and having many sinuosities. The arrangement of power stations in order to operate the cable in short sections would be a problem of some complexity and the cost of installation great.

The application of the cable to speeds such as are necessary upon the Manhattan system, has been incorporated by the Cable Rapid Transit Company, who hold patents for a motor with extended grip for hauling long trains. Not being dependent on adhesion, the motor could be of minimum weight, and there would be the further advantage of obtaining the assistance of down grade travel to balance the resistance of the up grade.

It is thought by some that the decision of the commissioners will be to indicate fresh avenues for occupation by the Manhattan railway. If so, it will be a peculiar commentary upon the claims of this progressive age that twenty years of research into the applications of motive power, twenty years of practical experiment under multifarious conditions, twenty years of books and societies and conventions, should not be able to produce an improvement upon the little puffing Billy cavorting around outside the first-story windows wriggling his tail behind him.

In a succeeding article it will be attempted to describe some of the other schemes which have been more or less prominently brought before the Rapid Transit Commission, including the Greathead system, Austin Corbin's Tunnels, The City Railway, Viaduct Railway, and the writer's scheme.

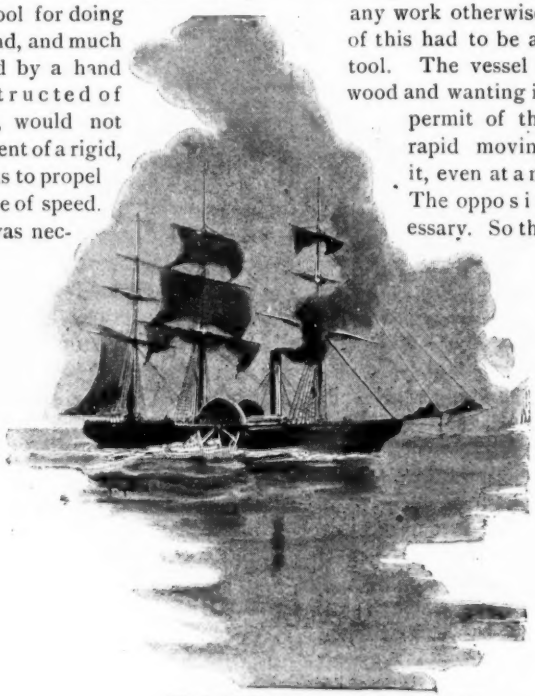


HOW few who sail out by Sandy Hook have the least idea that the first steamer that ever went to sea passed out of New York Harbor from Hoboken, where she had been designed and built by R. L. Stevens, an American. He had been experimenting with steam propulsion about the same time as Fulton but as the latter had obtained the exclusive privilege of navigating the waters of New York by steam, Stevens was compelled to seek some other locality for the employment of his vessel, the *Phœnix*. The Delaware was selected, and like a true engineer with confidence in his work he did not hesitate to put her out to sea and steam around to the new field of operations.

Scott Russell has written that "Robert L. Stevens is probably the man to whom of all others America owes the greatest share of its present highly improved steam navigation. Undoubtedly he is the pioneer of steam navigation on the open sea." To him also, no doubt, should be credited the design of the steam vessel which to-day is such a conspicuous figure on the Hudson. The fine lines, the ingenious bracing of the hull, the overhead working beam engine with its simple cut-off, the tubular boiler, and the many other features incorporated in this structure emanated from him.

We of to-day do not place this design as high as it deserves. Every piece of work should be judged by the conditions which surrounded its production. The engineer should study these conditions and prepare his design accordingly in order to produce

the best possible results. He cannot afford to design a highly sensitive apparatus if the material, the tools, and the workmen do not exist to make it. Such was the state of the art at the period of the adoption of this type of vessel. The workers in wood were numerous, whilst those in iron were few. The facilities for producing wrought-iron were not extensive. The machinist of to-day was unknown. The smith and wheelwright were the mechanics who fashioned the machinery. The turning-lathe was about the only tool for doing any work otherwise than by hand, and much of this had to be accomplished by a hand tool. The vessel being constructed of wood and wanting in stiffeners, would not permit of the employment of a rigid, rapid moving apparatus to propel it, even at a moderate rate of speed. The opposite of this was necessary. So the long



THE FIRST STEAMSHIP TO CROSS THE ATLANTIC.

stroke engine with its composite gallows frame, its long connections and its slow movement, was very wisely adopted as the best type of machine to work under these conditions. The long life of this apparatus, its easy movement and its excellent service, present much to admire. And it is not astonishing that those who have been using it so long should hesitate to discard it for the rapid, nervous machine of to-day.

The improvement of the steam navigation of the extensive rivers of our country, the natural roads of travel between different localities, occupied the attention of our people almost to the exclusion of the ocean until 1818, when at Corlear's Hook, New York, a steamer called the *Savannah*, of but 380 tons burden, was built. This vessel was the first one propelled by steam to cross the Atlantic. She was what might be termed an auxiliary side-wheeler, as her shaft was jointed so as to permit her wheels, which had been made to fold up like a fan, to be laid upon the deck. Her canvas wheel-house could be quickly furled to admit of this operation. The temporary character of the entire arrangement was such that when the sea was any way rough the wheels could not be used, so that the sails had to be called into play. The result was that she was frequently beaten by the fast sailing vessels.

After the *Savannah* a lull took place in this country towards the building of steam vessels for ocean navigation. Experiments, however, were being made in propellers other than the side wheel. In 1825 Samuel Brown fitted a two-bladed screw propeller to the bow of a canal boat. This wheel must have been very much like that which has been used of late years, except that the blades, instead of being placed opposite to one another, were arranged at right angles. They were, however, set at an angle of 45° to the axis. This placing of the blades at right angles must have had the same effect as the loss of two adjacent blades in a four-bladed propeller.

A second vessel with the same type of screw was afterwards built in England, and is said to have attained the speed of seven miles. These screw vessels ante-dated Ericsson's productions in this line. His first vessel, the *Ogden*, was built in 1836 and fitted with twin screws. These were like a turbine wheel ; that is, they consisted of a centre connected by a number of arms to a broad rim on the outside of which a number of spiral blades were fastened. This vessel is said by some authorities to have attained a speed of ten miles, and by others but four and a half.

An Act of Congress was passed in 1814 authorizing the President to have one or more floating batteries built for the defense of the waters of the United States. The Secretary of the Navy appointed a committee of five to take charge

of the construction of one such vessel. Robert Fulton was appointed engineer, and she was built from his designs. Her length was 150 feet, her breadth 56, and her depth 20 feet. There were two keels. In a well 15 feet wide and 66 feet long was placed a propeller or wheel, 16 feet diameter with 14 feet face of bucket, actuated by an engine with a 48-inch cylinder with 5 feet stroke of piston arranged in the hull on one side, whilst on the other the copper boilers were located. She was named the *Fulton the First*, and was the first war vessel propelled by steam. This was the largest steamer then built, and she had a tonnage of 2475. On her second trial trip 53 miles were made in eight hours. Her speed with guns and a considerable quantity of stores and ammunition on board, was two miles an hour against a three and a half knot current in the East River. Peace having been declared there was no use for her, so she was laid up on the flats in the Brooklyn Navy Yard, and afterwards accidentally blown up.

The next innovation was the *Princeton*, the first war vessel driven by a screw propeller. She was designed by Ericsson and built in 1843. Her dimensions were as follows: Length between perpendiculars 156 feet 6 inches; beam 30 feet 6 inches; hold 21 feet 6 inches; displacement at 18 feet draught 1046 tons; tonnage 673 $\frac{5}{95}$. She had a flat floor and sharp lines both forward and aft. Her machinery was entirely below the water line. She had telescopic smoke-stacks. The engines were direct acting coupled direct to the propeller. These engines were of the variety termed semi-cylindrical, having two cylinders each of 54 cubic feet capacity. Steam at 25 lbs. pressure was cut off at $\frac{1}{2}$ stroke in the cylinders. The screw propeller was 14 feet diameter, 35 foot pitch and driven at 36 revolutions per minute. The boilers had 134 square feet of grate and 2500 square feet of heating surface. They burned one ton of anthracite coal per hour with the assistance of forced draught. The hull was of white oak tree nailed. Launching weight 418 tons. Weight of engine, boilers and water 143 tons.

The *Midas*, built in 1844 by R. B. Forbes of Boston for the China trade, was a screw propeller. She was the first American vessel of her kind in the Chinese waters. Her boilers were neglected to such an extent that she was compelled to come home under sail, and as the boilers were never repaired, their use continued.

In the same year the steamers *Southampton* and *Bremen*, of 1700 tons each, were built for the Bremen trade. Their hulls were

of white oak, and they were fitted with side lever engines driving a side wheel. Their average time between New York and Cowes was 13½ days.

Where long voyages had to be made and where the coal consumption was necessarily large, with coaling stations limited in number and widely separated, attempts were made to employ steam power only as an auxiliary, as in the case of the *Savannah*. These attempts, however, have been but partly successful, it being a difficult matter to combine sail and steam power in an economical way, because the machinery and coal required the same amount of space whether they were or were not in use. A separate engine crew also had to be on hand and provided for whether the machinery was or was not in operation.

In 1845 Capt. R. B. Forbes of Boston built the *Massachusetts*, with an auxiliary screw propeller. She sailed from New York for Liverpool, and during the voyage of some 17 days used the screw about eleven days. She was the first screw propeller on this route. The *Southerner* and the *Falcon* were the first regular U. S. Mail steamships. They were built in 1846, and engaged on the line between New York and Charleston. Messrs. C. H. Marshall & Co. in 1846 had W. H. Webb build them the side-wheel steamer *United States*, of 2000 tons, for their Black Ball line between New York and Liverpool. She was the first American freight and passenger steamer built for this trade. Her time to Liverpool was 13 days, on a coal consumption of 40 tons per diem.

The pioneer ship bearing the American flag to the Pacific, was the *California*. It was an expensive experiment. No means were at hand on the Pacific side to make the necessary repairs. Shops had to be erected and equipped for this purpose. The necessary skilled labor was not at hand, and what there was had to be paid high wages. Fuel was scarce, coal commanding $30 per ton and sometimes running up to $50.

In 1849 George Law built the *Ohio* and *Georgia* for the trade between New York and California. These vessels were built of live oak, strengthened with 3-inch round iron extending the whole length of the vessel below the main deck beams. One was 2397 tons, the other 2695. Their engines were double and of the side lever variety, with cylinders 90 inches in diameter by 3 feet stroke of piston. The boilers, four in number, were of a new type, with five rows of flues and four furnaces. The speed of the vessels was 12 knots.

The Havre line was started in 1850, with the *Franklin* and *Humboldt;* one 2400, the other 2800 tons. They were fitted with side lever engines and side wheels. The boilers were four in number made of iron with flues back to back. Their time between New York and Cowes was about 12¾ days.

The first American transatlantic line of any pretensions was the Collins. When their steamers were completed in 1851 a great rivalry with the Cunard line at once sprang up. In the contests which followed in this year and in the following one, the *Baltic* of the Collins line carried off the palm, making the quickest run between New York and Liverpool in 9 days 13½ hours. The dimensions of the *Baltic* were as follows: Length between perpendiculars, 280 feet; beam, 46 feet; depth of hold, 24 feet; displacement 3724 tons at 19 feet draught. Weight of hull, which was of live oak, 1380 tons. The rig was that of a brig. The engines were of the side lever variety having two cylinders 95 inches diameter and 10 feet stroke of piston. She was propelled by radial side wheels 34 feet 5 inches diameter, having buckets 21 feet 6-inch face, at a rate of 12$\frac{2}{10}$ knots per hour. The steam was supplied by four vertical tubular boilers with double-storied furnaces, the gases being led into one smoke-stack. The boilers were 20 feet 7 inches long and 13 feet 8 inches high; two being 14 feet wide and two 15 feet. The steam pressure was 17 less per square inch cut off at ½ stroke in the cylinders driving the engines at an average of one 14$\frac{7}{10}$ strokes per minute. The fuel used was bituminous coal of which 7640 lbs. were consumed per hour with natural draught.

In 1852 Commodore Perry sailed from Norfolk, Va., in the U. S. steam-paddle frigate *Mississippi*, the flag-ship of the Japan Expedition. This vessel was the first U. S. war steamer to circumnavigate the globe. She went to Japan via the Cape of Good Hope, and returned via Cape Horn. The time of her absence was two years and five months.

The steamer *Golden Age* was despatched to Liverpool in 1853, where she attracted considerable attention. She also gave rise to considerable comment on account of the absence of the bowsprit and showy figurehead, features which at that time in England were considered necessary to the beauty of a vessel. She was a large and high-powered steamer. The latter quality enabled her to make a record-breaking trip to Australia. Continuing her voyage from Sydney, she made the run to Panama in about thirty-nine days, including a stop-

page of six days to coal. Her mails, money and passengers were immediately transferred across the Isthmus to the steamer *Magdalena*, which enabled her letters to be received in London in sixty-seven days from Sydney. This performance was a remarkable one, and the English press dwelt upon it as a credit to American enterprise, in opening direct steam communication across the vast Pacific, and connecting Australia and Europe by the medium of Panama. It was regarded as the dawn of a new era, the breaking-in upon the isolation of a field which had heretofore been looked upon as one of adventure rather than of regular commerce, and as the inauguration of a movement which would probably lead the commerce of this ocean to advance beyond that of the Atlantic, as the latter had eclipsed that of the Mediterranean.

In 1857 the wooden steamer *Vanderbilt*, with overhead working beam engines, made the run from New York to the Needles in 9 days and 8 hours, and on the home run in 9 days, 9 hours and 24 minutes. In the same year W. H. Webb built for the Russian Government, at a cost of $1,125,000, the 70-gun ship *General Admiral*. She was 325 feet long, 55 feet beam and 34 feet depth of hold. Her horse-power, derived from two horizontal engines, was 800. She had a single lifting screw. Her speed under canvas was twelve knots per hour. She made the voyage between New York and Cherbourg under steam in eleven days and ten hours.

The Rebellion brought out a new type of coast-defense vessel, dubbed the *Monitor*, or something to admonish the leaders of the Rebellion that their batteries would no longer be barriers. She was built in 1861, from the designs and under the superintendence of Ericsson. She was a vessel with but little freeboard, having a belt of iron running around the sides and ends, and plating of iron on top of her deck. One cylindrical turret mounting two guns revolved by machinery was mounted on the deck. The board of officers to whom the plans were submitted reported on them as follows:

"This plan of a floating battery is novel, but seems based on a plan which will render the battery shot and shell proof. We are apprehensive that her properties for sea are not such as a sea-going vessel should possess. But she may be moved from one place to another on the coast in smooth water."

Their views were borne out in practical service; the former quality being happily fully up to, whilst the latter was sadly below

what they had asserted, in that she foundered at sea carrying at least one-half of her officers and crew to a watery grave. But she performed a noble part in the contest with the *Merrimac* in Hampton Roads.

Up to about 1860 steam was not carried higher than 25 lbs., nor expanded more than twice. Surface condensation had been tried, but had not proven very satisfactory. The jet condenser with the expensive process of blowing off had not been laid aside. At this time John Elder of Glasgow turned his attention to a higher development of the marine engine. He began the employment of steam at 42 lbs. pressure in connection with a higher grade of expansion. He did not attempt the expansion in cylinders of the same diameter, however, but following the teachings of Watt employed two of different diameters, so that the range of temperature in each would be kept as low as possible. In this way he was enabled to cut down the coal consumption from between 5 and 6 lbs. per indicated horse power per hour, to 2½ lbs. The saving in fuel was not the only gain derived from this improvement, for with it the strains upon the journals were cut down, as well as the total weight of engines, boilers and water, which at the same time occupied reduced space. The feed-water was heated before entering the boilers, but the exhaust steam was still condensed by the application of a jet of salt water. This was the dawn of a new era, from which so much was to be gained in after years.

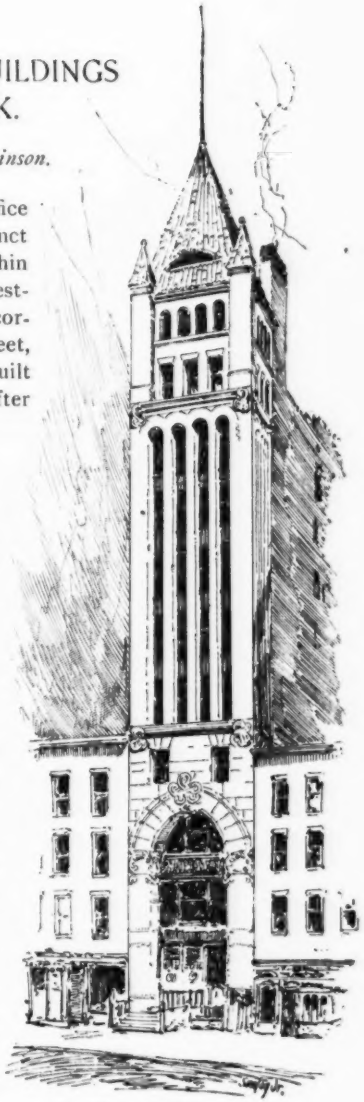
THE TALL OFFICE BUILDINGS OF NEW YORK.

By John Beverley Robinson.

THE evolution of tall office buildings, as a distinct class, has occurred within a few years. The Western Union Building, at the corner of Broadway and Dey Street, with its eleven stories, was built in 1873, and shortly thereafter the *Tribune* Building, on Printing House Square, with ten stories.

Previous to that the typical office building was but five or six stories high, and the Equitable Building, the comparatively small beginning of the present immense mass, was one of the best specimens. With the invention of the hydraulic elevator, as distinguished from the earlier machine-lifts, and with the rapidity of action that became practicable with this improvement, the height of buildings at once began to be increased.

As the perfection of elevator work is the one fundamental condition for high buildings, it may be well to note clearly the nature of the change in elevator machinery which directly led to the



THE TOWER BUILDING—NEW YORK.

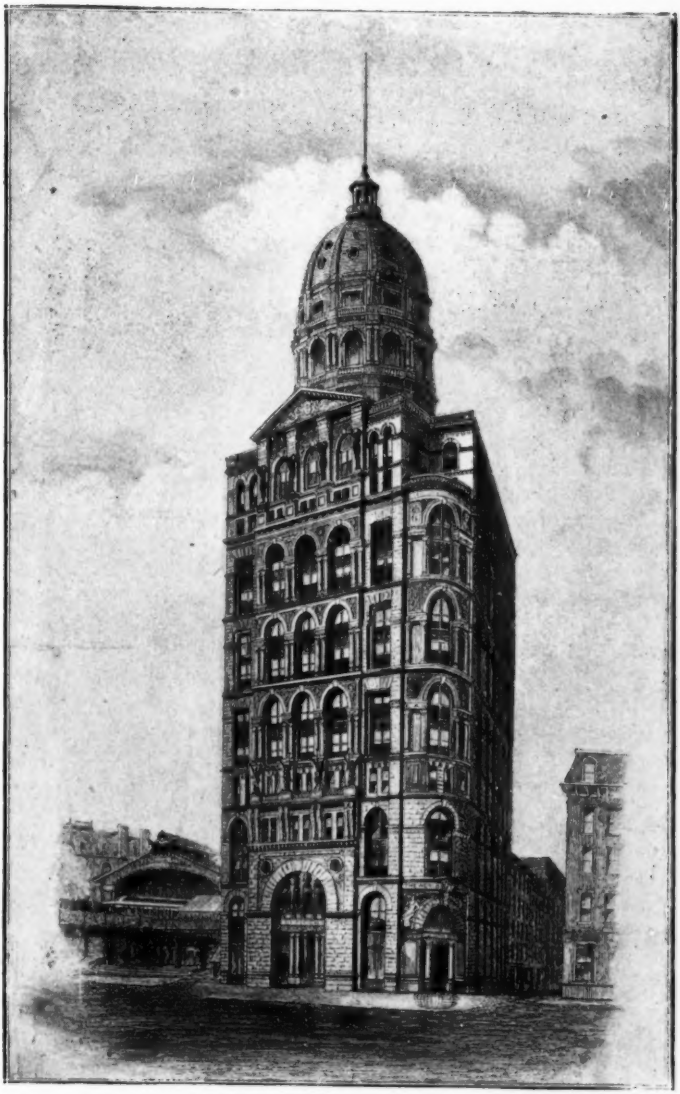
construction of very high buildings. Before hydraulic elevators were invented steam elevators were chiefly used. In these a steam-engine was the motive power, directly connected with the car by windlasses, pulleys, and other hoisting devices. Hydraulic elevators, on the contrary, have no direct connection with the source of power. They are lifted by the weight of a column of water, sometimes aided by atmospheric pressure acting upon a piston and cylinder placed near or in the well in which the car moves. In steam elevators and in those moved by gas engines, turbines or other prime movers directly connected, there is more or less vibration from the machinery, which increases rapidly as the speed increases, rendering high velocities in travel impracticable. Hydraulic elevators move with a gliding motion, in which no jar or vibration is observable, and by their use very high velocities for the car are obtained.

Should the height of buildings be pushed much beyond present limits, it is probable that other devices will have to be added to secure rapid access to the upper stories. Elevators might perhaps be run in such a way that each one of a group would serve several stories, making no stop below the allotted portion ; and we may see notices in the future thus : "This elevator to the 15th, 16th, 17th and 18th stories. No stop below the 15th story."

After the way had been broken, tall buildings multiplied rapidly. The Coal and Iron Exchange, the Boreel Building, Temple Court, the Welles Building, the Standard Oil Co.'s Building, the Washington and Morse buildings, and a dozen others which might be enumerated.

We have spoken so far only of the tall office buildings of New York. Other cities possess lofty buildings, some indeed surpassing in size anything that New York can show, such as the Rookery and the Auditorium of Chicago, and still more recent and more lofty structures. But owing to its contracted building space, it is probable that New York will continue to be the city where the very tall building, on a comparatively small ground-space, will tend to develop and will be seen in perfection.

The challenge of the *Tribune* lay for some years unaccepted. Recently, however, it was taken up by the *Times*, which erected a building overtopping the *Tribune*, and not a hundred feet distant from it ; and still more recently the *World* has cast them both into the shade in point of height attained, with nineteen stories including those in the dome.



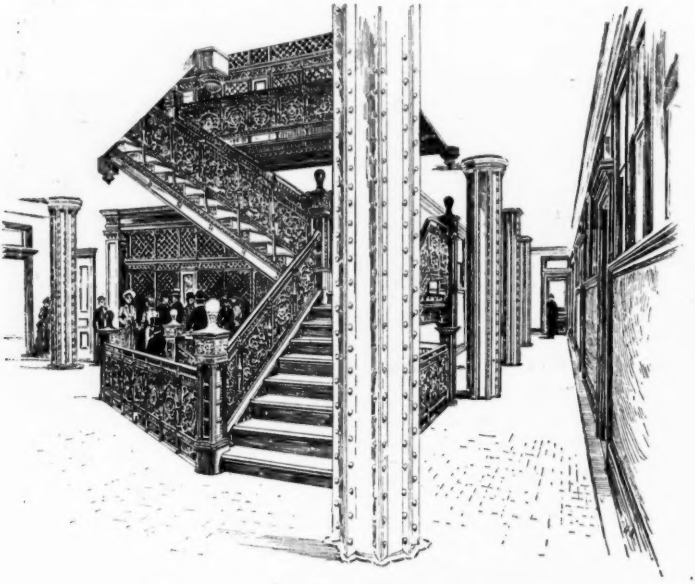
THE WORLD BUILDING.

ENTRANCE TO THE WORLD PUBLICATION OFFICE.

Certainly this group of newspaper buildings is one of the most remarkable city landscapes to be seen anywhere. It will not be less remarkable if the *Sun* carries out a suggestion that it recently made as to the possibility of its putting up a building of some thirty-two stories, and nearly four hundred feet in height upon a plot of ground but seventy-five feet square. The sketch for this building is reproduced on another page of this article. For such a structure ordinary methods of construction would have to be abandoned. Brick and stone would not with safety withstand the enormous pressure upon the base, and the bulk of these materials in the massive walls required would seriously diminish the available floor space. But such problems have already been encountered and successfully solved in several instances, notably the Tower Building on lower Broadway which is twelve stories high with but twenty-two feet of frontage.

THE TIMES BUILDING.

As we look at the group of splendid newspaper buildings facing the City Hall and Court House, and reflect with what ease, speed and economy they were put through, one after the other, while for years the city government has been trying to secure a high building for its own use without succeeding in making a beginning—and even its existing buildings are monuments of corruption, extravagance and fraud—the reflection is forced upon us that our present governmental methods are failures as compared with the business methods of the men towards whom the government is



ONE OF THE PUBLIC HALLWAYS OF THE WORLD BUILDING.

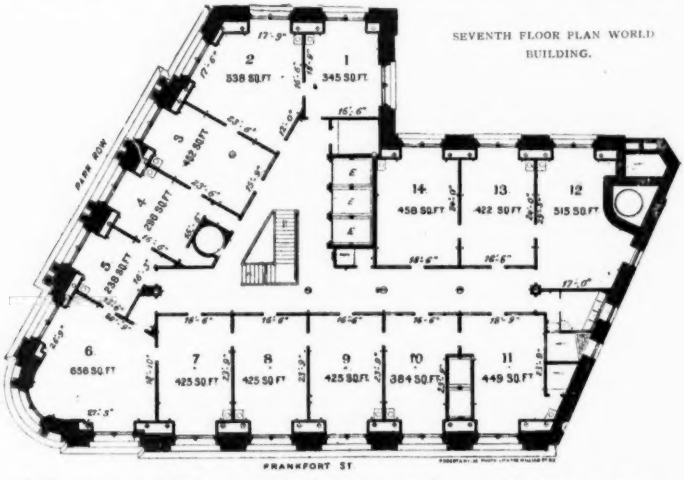
reverently supposed to stand as a superior.

After the elevator system, the very first requirement of an office building is that every room shall be amply lighted. Where the building stands upon a corner, or with three sides exposed as in the *Times* building, the question of light presents no difficulties. But when the frontage is limited, courts, light wells and similar devices become necessary and conflict is apt to arise between the architect and the owner. To sacrifice valuable floor space for spacious internal courts seems to the owner, not unnaturally, out of the ques-

THE TRIBUNE BUILDING.

tion ; while the architect is usually anxious to secure the manifest advantages of both light and air for the offices that large light spaces give. As a matter of fact those office buildings where space seems to be almost wantonly wasted for such purposes are the most successful. Each room being desirable, the highest rents are obtained and the building is easily kept filled. Instances of this treatment are seen in the Boreel and in the Mills buildings. Where light spaces are necessary, it is a mistake from every point of view to reduce them to a minimum.

How far progress in science may in future enable us to dispense with natural light it is hard to say. If electric lighting were used by bulbs placed in the ceiling of rooms, or otherwise, so that the



SEVENTH FLOOR PLAN WORLD BUILDING.

whole room would be evenly illuminated without shadows and without glare, and if adequate ventilation by natural draft or by mechanical blast could be obtained, there is no apparent reason why we should not do without windows entirely, building our blocks solid, each room a cell with doorways the only openings. A vast saving of space might in this way be made. It has been asserted that the electric light produces headache and, if continuous, greater ills ; but the facts seem to be insufficiently proved.

As to ventilation, it will not do to depend upon windows entirely, even where they can be obtained. The steam or hot water heat from radiators, which are the only practicable methods of heating

PRINTING HOUSE SQUARE AT EVENING.

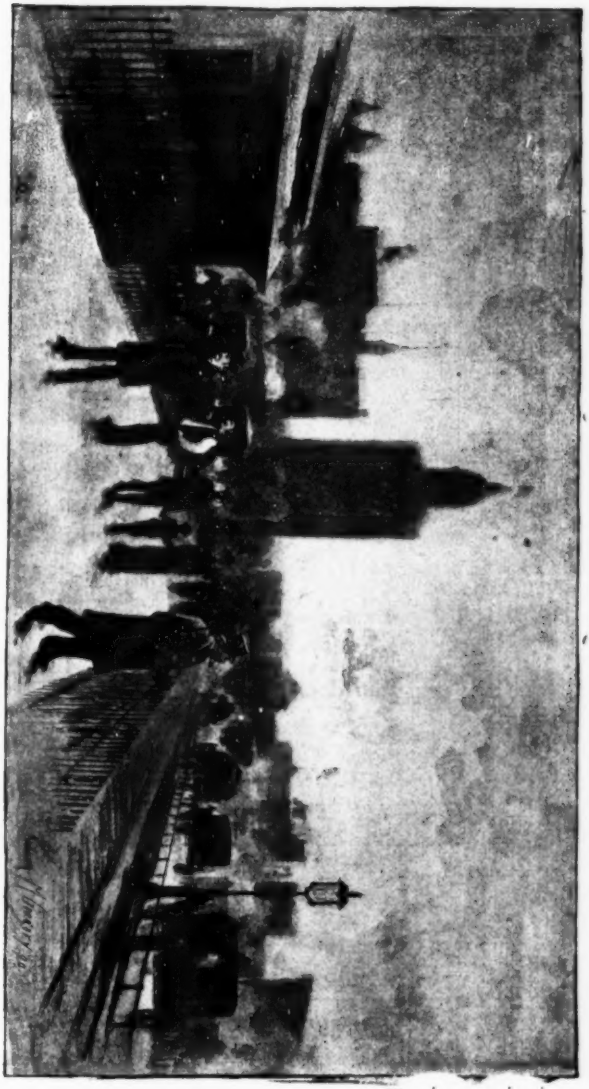
large buildings, renders necessary some system of exit for exhausted air and of inlet for fresh air. It may be possible, therefore, to dispense with windows in the future or at least to use them only where they can be conveniently obtained, and for the rest to exist in an artificial light of perfect quality, in an atmosphere obtained by artificial means. At present, of course nothing of this sort is attempted; but, with the enormous increase of land values that must be expected in the lower part of New York, it would not be surprising if the future should produce something of the sort.

Next to light, we must place simplicity of arrangement in importance. From the point where the elevators deliver in each story, the door of every office on that floor should be visible; or, at least the corridors leading thereto should be plain and unmistakeable. Nothing is more distressing than a labyrinth of halls and passages, with endless spurs and unexpected twists and turns, ending in *culs-de-sac*, mere nothing, or quite impartially in important offices or janitors' dust bins. Plain, straight, coherent, giving an idea of the whole scope of the building at first glance—such should be the ideal to strive after in arrangement.

Economy of space in planning is of course paramount where rental is the object. Economy may, however, be pushed too far. Waste of space, when it means brightly lighted halls and rooms, when it means spacious and attractive corridors, is often the wisest economy possible. A great saving may be made by reducing the stairs to a minimum. Even now the elevator to a great extent takes the place of stairs. People wait for it to ascend even one story. This will be the case more and more as the elevator system grows in perfectness. It is wise, therefore, to reduce the stairs as much as possible, and to use the often very large space occupied by them for rental. This is done in the Schermerhorn building in Wall Street with great discretion and marked success.

In speaking of the suggested *Sun* building we have alluded to the modifications in construction that are required for very tall buildings, especially for those built on very contracted plots. The earlier high office buildings, such for instance as the Western Union Building, were constructed upon substantially the same principles as an ordinary two-story brick house. The walls, although concentrated into piers, were of brick and stone masonry wholly. Upon these rested the beams which formed the floors.

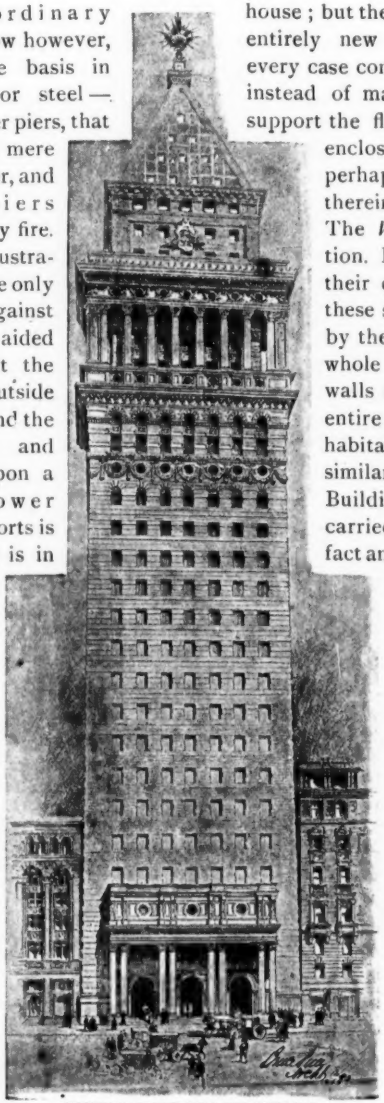
The beams were of iron, to be sure, and the space between was filled with brick arches instead of the wooden beams and inch floor-



A VIEW FROM THE BROOKLYN BRIDGE.

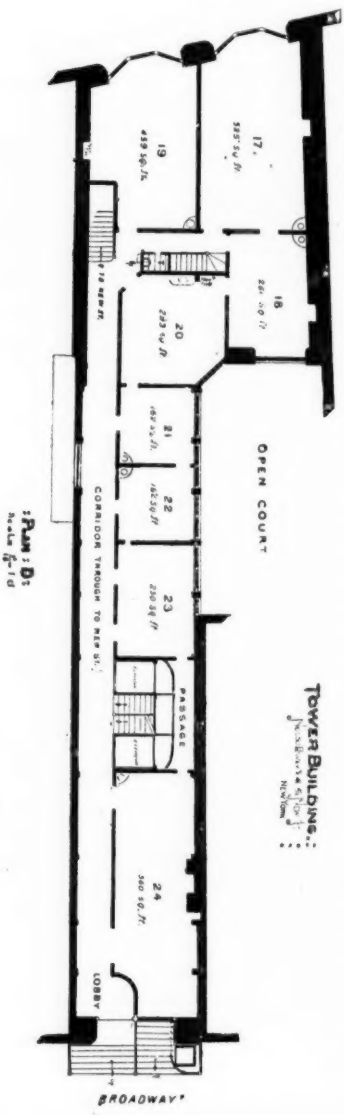
ing of the ordinary house; but the principle was identical. Now however, entirely new systems are arising. The basis in every case consists in using metal—iron or steel—instead of masonry for the walls, or rather piers, that support the floors, reducing the walls to a mere enclosure to keep out the weather, and perhaps to protect the iron piers therein encased from destruction by fire. The *World* building is a good illustration. In this the outside walls have only their own weight to support. Against these stand iron columns, which, aided by the interior columns, support the whole weight of the floors. The outside walls might in fact be removed and the entire interior would stand intact and habitable. The *Times* building is upon a similar system.

In the Tower Building, the system of metal supports is carried even farther. The building is in fact an iron construction; as much so as A. T. Stewart's building at Tenth Street and Broadway. It is simply a series of iron posts, connected by horizontal iron parts, upon which rest the iron floor beams. Upon them rests also the outside wall for each story, so that the whole of the outside walls in the first story might be removed, leaving the walls of the upper stories untouched. The building would then be seen to be supported by the iron columns which are now embedded in the brick walls.



DESIGN FOR THE NEW SUN BUILDING.

INVENTION, THE FIRST TORCH-BEARER.—WORLD BUILDING.

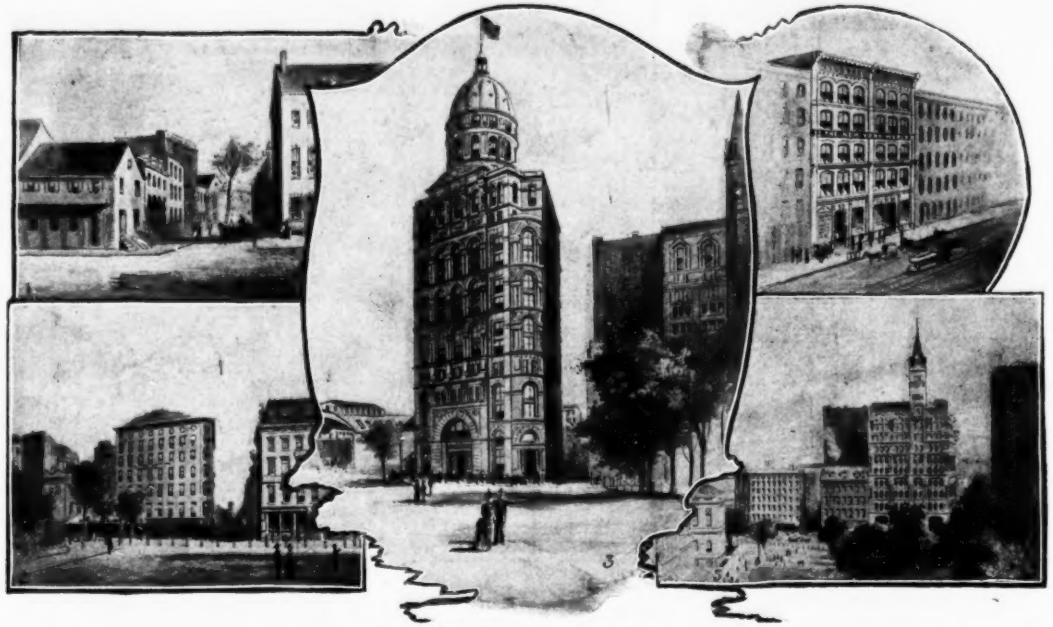


A very great advantage in narrow lots is thus obtained. An ordinary masonry construction of the height of the Tower building would need walls three or four feet thick in the lower stories. By the use of iron columns this is diminished to one and a half or two feet.

This would mean that, upon a twenty-five foot lot, twenty-one feet of interior space in width would be available instead of seventeen. Another high office building in New York at the corner of Broadway and Morris Street, is built upon the same principle.

Should the building proposed by the *Sun*, or another of about the same character which is proposed in St. Paul, be really attempted, it is probable that the system of metal construction would have to be carried even further. There is no reason, though, why these immensely tall structures could not be safely built as far as construction is concerned.

The advantages to the occupants of tall buildings are many, apart from the advantages to the owner in the way of rental. Lifted above the streets to the height of an ordinary church steeple, the noise and clatter of a great city are dulled merely by distance into an unobtrusive monotone. Often, indeed, private enter-



FIVE ERAS IN THE HISTORY OF PARK ROW.

1. Site of the World Building in 1820, showing Tammany Hall at the right. 2. The site in 1870, showing French's Hotel. 4. The old World Building at 32 Park Row. 5. The site of the World Building in 1888, showing French's Hotel, and the Tribune Building at the right. 3. 1890, the World Building appears on its historic site.

Diagram A

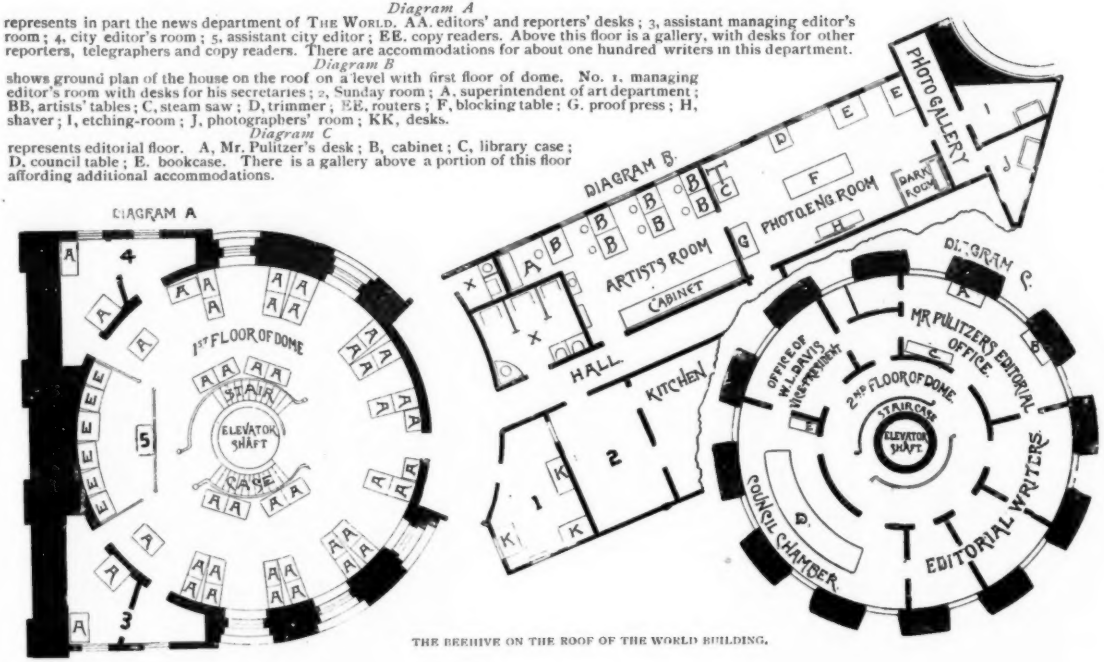
represents in part the news department of THE WORLD. AA. editors' and reporters' desks ; 3, assistant managing editor's room ; 4, city editor's room ; 5, assistant city editor ; EE. copy readers. Above this floor is a gallery, with desks for other reporters, telegraphers and copy readers. There are accommodations for about one hundred writers in this department.

Diagram B

shows ground plan of the house on the roof on a level with first floor of dome. No. 1. managing editor's room with desks for his secretaries ; 2, Sunday room ; A, superintendent of art department ; BB, artists' tables ; C, steam saw ; D, trimmer ; EE, routers ; F, blocking table ; G. proof press ; H, shaver ; I, etching-room ; J, photographers' room ; KK, desks.

Diagram C

represents editorial floor. A, Mr. Pulitzer's desk ; B, cabinet ; C, library case ; D, council table ; E. bookcase. There is a gallery above a portion of this floor affording additional accommodations.



THE BEEHIVE ON THE ROOF OF THE WORLD BUILDING.

prise again comes in where governmental methods fail, and the owners of these buildings lay smooth asphalt pavements at their own expense to diminish the noise of vehicles, especially in the lower stories.

In addition to the quiet, a degree of privacy is obtained which for many men is invaluable. Instead of a perpetual tramp through the halls, nobody comes to the upper stories but those who are in search of the offices there. Chief among the advantages again is the clear sweep of fresh air, which in summer makes a visit to the top of a high building almost like a trip to the beach. While others are sweltering in the breezeless canyons of the streets, the tenants of our high buildings are enjoying the usual sea breeze that blows over New York, with every window in their lofty perches wide open.

Add to this the view which lies spread before the eyes of the seventh story tenant—always grand and inspiring, be it summer or winter.

On one side the great city with no discernible end, as yet unblackened by bituminous coal smoke. On the other side the bay, with innumerable turtle-back ferryboats, and white river steamers, and black ocean travellers continually going and arriving through the Narrows, beyond which we catch a glimpse of the white sand beach and the dark blue sea beyond. Are not such surroundings something worth having; something to relieve business monotony and care, and to ward off the impending nervous exhaustion?

But these are merely the advantages of situation: some of them indeed may vanish when all buildings are high. In addition are conveniences and comforts on all sides. On each floor a washroom with complete plumbing in the most perfect and costly equipment; in each office usually a wash-bowl. In the Western cities the best office buildings are supplied with hot as well as cold water, but in New York a hot-water supply is rare if indeed it is not unknown. In the hall on each story there is an opening to the mail chute, through which letters can be mailed without even going down-stairs.

In addition to the usual gas lighting in the offices, electric light is beginning to be looked for as a matter of course; and in either case the lighting is usually included in the rental. Heating we have spoken of, and this too is included in the rental. Telephone and electric call service are still separately provided by the tenants, although the office buildings of the future might well arrange for a central telephone service for the building, with which each office

might communicate; or a general telephone for the use of tenants gratis might be provided, just as now telegraph offices are provided in the lower halls of some buildings. Indeed if we mistake not, this telephone service has actually been provided by at least one great building.

As for the advantage to the owner in the way of rental, it is hard to give a precise statement. So much depends upon the location of the building, and so much upon the location of the rooms in the building, that the variation in rents is very great.

Ordinary upper story offices in first-class buildings, situated on important business streets, are found to rent for from $2.50 to $3.50 per square foot of floor surface. Few if any bring less than $2.50, while the large offices on the lower and street floors bring much more than the highest figure given.

This is three or four times as much as is obtained for floor space in the upper stories of old-time buildings. In the latter, moreover, the price falls very rapidly with each flight of stairs, while in the modern elevator buildings, the price is approximately the same above the two or three lowest stories.

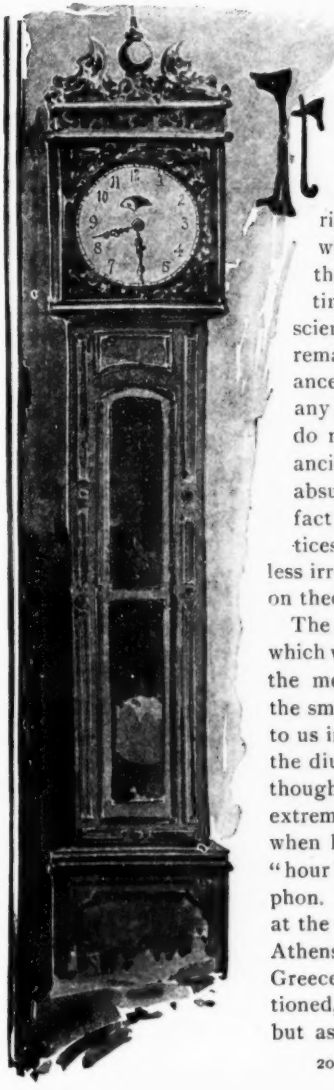
As a partial offset, the rental in the modern building usually includes heating, electric or gas lighting, and janitor's services, all of which are extras in the old style building.

So far the development of the great office building with its many advantages and conveniences, from the old-time barrack with the sink in the hall, has been most interesting and instructive.

A similar evolution in dwelling-houses was once upon a time fairly begun. The convenience of life upon a vertical instead of a horizontal plane, was about to be demonstrated or practically disproved. High apartment houses with fast elevators, perfect plumbing, and all the gains in light, air and sunshine were here and there erected, and more and bigger ones were planned. The movement came to an untimely end. Unknown "interests" scraped together sufficient "influence" at Albany to frustrate the attempts of those who would provide and of those who would occupy such homes to come together.

Briefly, they "got a law passed" prohibiting high dwellings. We must wait for the future to restore to us privileges in the matter of dwellings which have been graciously permitted to remain to us in the matter of offices.

OUR OLD-FOGY METHODS OF RECKONING TIME.



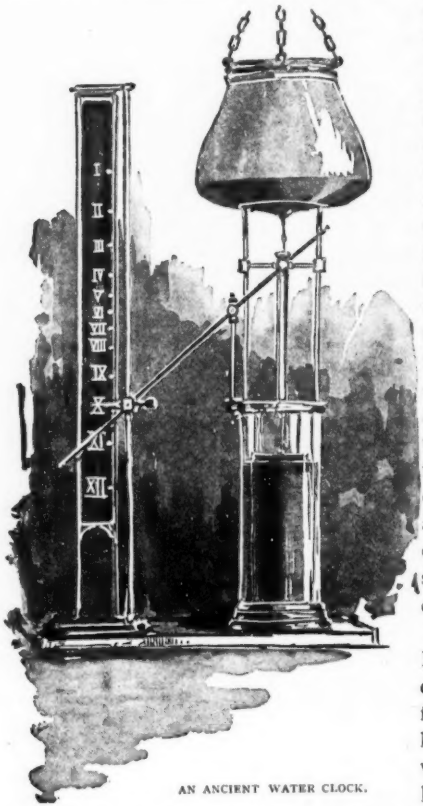
By Sandford Fleming,
C. E., LL. D., C. M. G., Etc.

It is only within the last fifteen years that special attention has been directed to the unsound principles, the untenable theories, and the curious old usages which still prevail with respect to the measurement and notation of time. In spite of the advance in science in other directions, we have remained until now rooted in observances which cannot be defended on any rational or scientific ground. We do not suppress our ridicule at many ancient customs which appear to us absurd, but we remain blind to the fact that some of our every-day practices in the reckoning of time are not less irrational, and that they are based on theories which cannot be sustained.

The three great divisions of time with which we are most familiar are the year, the month, and the day. The latter is the smallest measure of time revealed to us in nature, and is dependent upon the diurnal rotation of the earth. Although the subdivision of the day is of extreme antiquity, there was a time when hours were unknown. The word "hour" is not found in Plato or in Xenophon. For the first time it is met with at the period of the Macedonian rule at Athens. In the early literature of Greece the Hours (Horai) are mentioned, not as the divisions of the day, but as the goddesses of the Seasons,

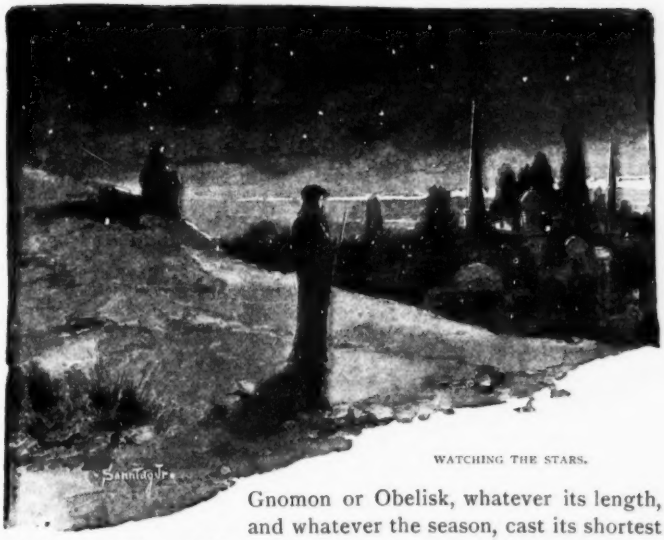
maidens of beauty bearing the products of the earth, and attendant upon Venus as she rose from the sea.

With a primitive people the crowing of the cock was a means of making known the early dawn. While the position of the sun in the heavens enabled mankind to estimate the passage of time during the hours of sunlight, the progress of night was determined by the position of the stars. The custom of dividing the day into two series of twelve hours took its origin long before the Christian era. The Arcadians counted the night from sunset to sunrise, with a subdivision of twelve parts. To effect this they observed stars or groups of stars which appeared at intervals in the eastern horizon and the intervals were thus denoted with sufficient accuracy. By analogy the day from sunrise to sunset was similarly subdivided.



AN ANCIENT WATER CLOCK.

Both in Greece and Rome Gnomons were erected in open ground for the public benefit, the length of the shadows of which denoted the several hours. Magistrates were charged with the duty of watching the shadow and announcing in a loud voice the moment of mid-day, morning and evening. A few persons of wealth maintained their private Gnomons, with slaves to watch the progress of the shadow. It is generally supposed that the great obelisks of Egypt, some of which still remain, were the clocks of the Ancients. One fact was early noticeable, that the



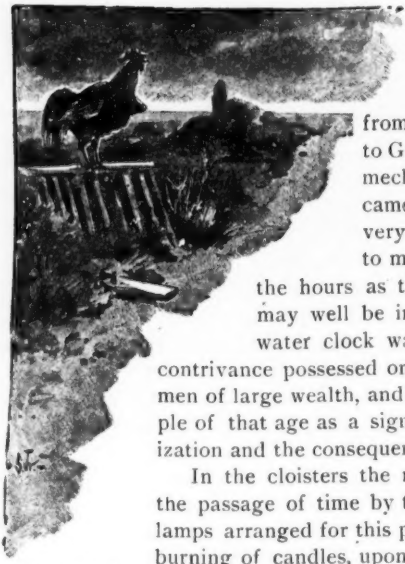
WATCHING THE STARS.

Gnomon or Obelisk, whatever its length, and whatever the season, cast its shortest shadow at an invariable period of the day; thus mid-day naturally became established at an early date as an important point of time.

An advance was made in the art of measuring the passage of the sun by the introduction of sun-dials, when a certain degree of precision was obtained. Herodotus tells us that the concave dial and the ordinary sun-dial were brought from Egypt, with the division of the period of direct sunlight into twelve parts, all of which "the Greeks learned from the Babylonians."

Obviously the hours, being each a twelfth part of the two intervals between sunrise and sunset, varied in length in the different months. Throughout the temperate zone, hours determined on this principle constantly varied. In one half the year the hours of the night, in the other half those of the day, were longer. Only twice in the year, at the equinoxes, were the hours of uniform length.

Gradually mechanical contrivances were introduced to overcome the impossibility of observing the time by the sun or stars during cloudy weather. The first mechanical means employed was the flow of water, drop by drop. Mechanisms of this kind were called by the Greeks clepsydras, and were of various forms; in one class the flow of water was weighed, in another the volume

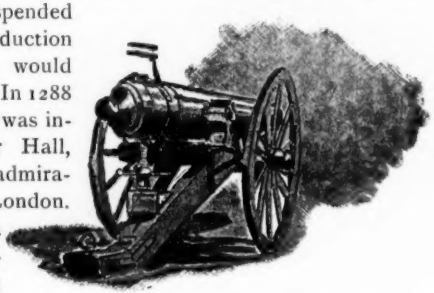


BREAK OF DAY.

was measured. The clepsydra was introduced into Egypt at the time of the Ptolemies, and from thence it found its way to Greece and Rome. In these mechanical movements it became necessary to introduce very complicated contrivances to mark the variable length of the hours as the seasons advanced. It may well be imagined that the ancient water clock was a great and cumbrous contrivance possessed only by royal personages or men of large wealth, and was regarded by the people of that age as a sign of the advance of civilization and the consequence of intellectual culture.

In the cloisters the monks contrived to mark the passage of time by the consumption of oil in lamps arranged for this purpose; elsewhere by the burning of candles, upon the wicks of which were placed a series of knots at calculated intervals to mark periodic duration. In course of years sand-glasses were employed. Generally they were regulated to be reversed at the end of each half hour, in which case it was indispensable to have attendants to turn them forty-eight times a day.

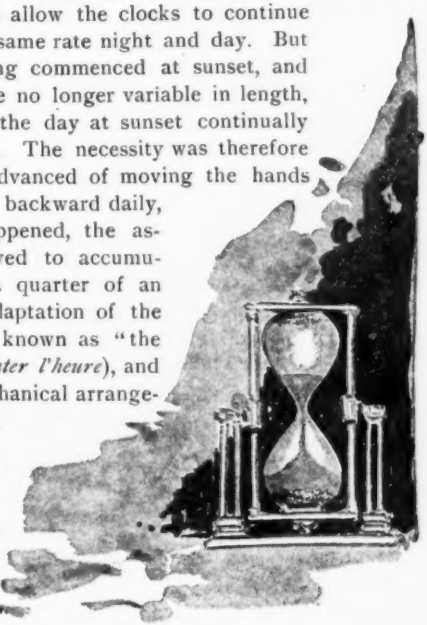
The great defect of all these contrivances was that they had no principle of continuity, and incessant watchfulness had to be observed. An effort was therefore made to supersede them, by having recourse to suspended weights and the introduction of wheel-work which would move with regularity. In 1288 one of these machines was installed at Westminster Hall, and it drew forth the admiration of the people of London. Half a century later a similar mechanical combination was erected at Dover Castle, and about



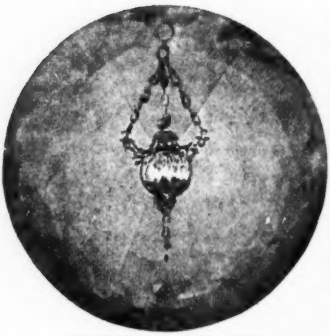
THE NOON HOUR BY CANNON.

the same date wheelwork clocks were placed in the church of St. Gothard, at Padua, and at different points in Europe.

In every one of these complicated instruments the exigencies of "use and wont" had to be taken into account. Public opinion of those times would not countenance the adoption of hours of uniform length throughout the year. It was exacted that the subdivisions of the day and night should remain distinct, and should vary with the change of seasons. So late as the fifteenth century this strange system of counting the passage of time by hours of unequal length remained in force. Gradually its absurdity became apparent and the desire arose to allow the clocks to continue their movements at the same rate night and day. But as before, the reckoning commenced at sunset, and although the hours were no longer variable in length, the commencement of the day at sunset continually varied with the seasons. The necessity was therefore created as the seasons advanced of moving the hands of the clock forward or backward daily, or as it frequently happened, the assumed error was allowed to accumulate until it reached a quarter of an hour. This continual adaptation of the hands on the dial was known as "the leap of the clock" (*sauter l'heure*), and however perfect the mechanical arrangement, it was vain to look for precision or uniformity of reckoning under such a system.



The incessant interference, the daily application of thumb rule to move the hands some-



ANCIENT TYPE OF OIL LAMP.

times forward, and at other times backward, an operation termed "regulating the clock by the sun," required so much attention that the ingenuity of skillful men turned to a search for some means of making the changes automatically. M. Houzeau in a lecture before the Royal Belgian Geographical Society, March, 1888, remarks on this point: "Never was human ingenuity expended upon an object so irrational and of such little merit. But habit which had lasted for centuries was at stake, and habits never reason, they exact." Towards the end of the last century these wonderful machines with automatic complications for pushing forward or retarding the hours were objects of admiration in most of the capitals of Europe, and so late as 1806 an honorary distinction was conferred by the French emperor on the inventor and maker of a clock possessing the proper increment needed to change with accuracy the hands on the dial every day at all seasons.

Some years before this date, however, the question was being asked, what advantage results from having a daily change in the hours; why not have uniformity night and day, summer and winter? The spirit of inquiry eventually resulted in the introduction of what we now call "mean-time"; but to effect the change was a movement of great difficulty. In the words of M. Houzeau:

"It was a greater revolution than we are now capable of imagining. There was between this uniform time, which we call "mean-time," and the time of the people or of the sun, sometimes the difference of a quarter of an hour. Out of this divergence the populations created a scarecrow at which we are forced to laugh. The mid-day by the sun or the middle of the day will no longer, they said, accord with twelve o'clock. Tradesmen, day-laborers, will be bewildered, and their work disarranged. The forenoon will be sometimes longer, sometimes shorter, than the afternoon. Bakers deceived by the clock will no longer be ready in time, and the people will be in want of bread. I in no way exaggerate. But is not this the history of all reforms? And what did the fears amount to? We have to-day mean-time, without the immense majority of our con-

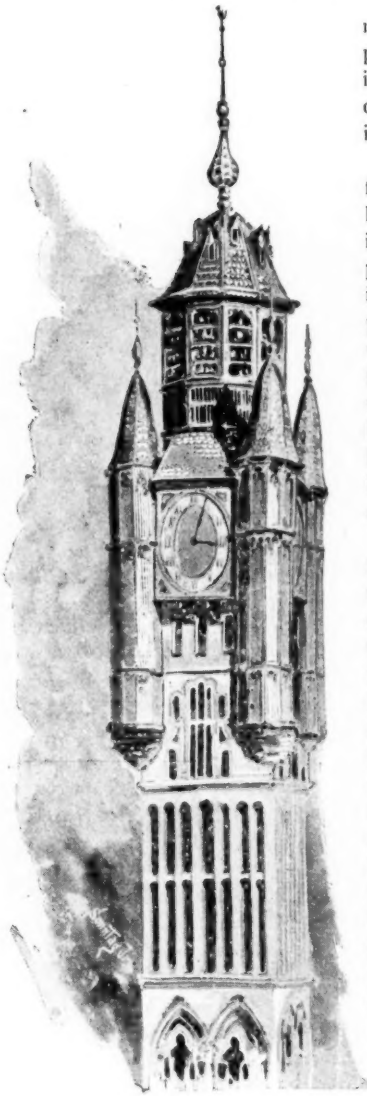
DOING HOURLY PENANCE BY THE TAPERS.

temporaries having the least idea that any other notation was ever followed."*

The introduction of mean-time into common use was only effected after much opposition. It took its origin in Geneva in 1780, and slowly made its way. In London the variable hours ceased in 1792. It required another eighteen years to overcome the old custom in Berlin, and it is difficult to believe that Paris did not renounce the daily alteration of its clocks until 1816.

We smile at these practices, and wonder at the persistency with which they were clung to, even after their absurdity became recog-

* Houzeau, Histoire de l'heure, pp. 182–3. The writer is desirous of acknowledging his obligation to this publication.



AN OLD CLOCK TOWER IN BERGUES

nized. Another generation may perhaps laugh at those living in this century for adhering to customs not less open to ridicule.

What reason can we give for using the double series of hours, repeating one to twelve in each half of a single diurnal period; a practice which originated in primitive times, the purpose and significance of which have long since been forgotten? Who in this railway age would think of regulating the movement of trains by the shadow of the sun during the day, or by the progress of the stars during the night?

Again, there is a general belief throughout Christendom that Sunday is simultaneous over the world. What would the rigid Sabbatarian say if told as a matter of fact that Saturday extends into the middle of Sunday, and Monday begins when Saturday ends; and while this is actually the case, Sunday itself extends from the end of Friday to the first hour of Tuesday, ranging over forty-eight hours: further, that the same anomaly is common to each of the seven days of the week. Again, "local time" is a familiar expression, but it is entirely incorrect. There is no such thing. The expression "local time" is based upon the theory that

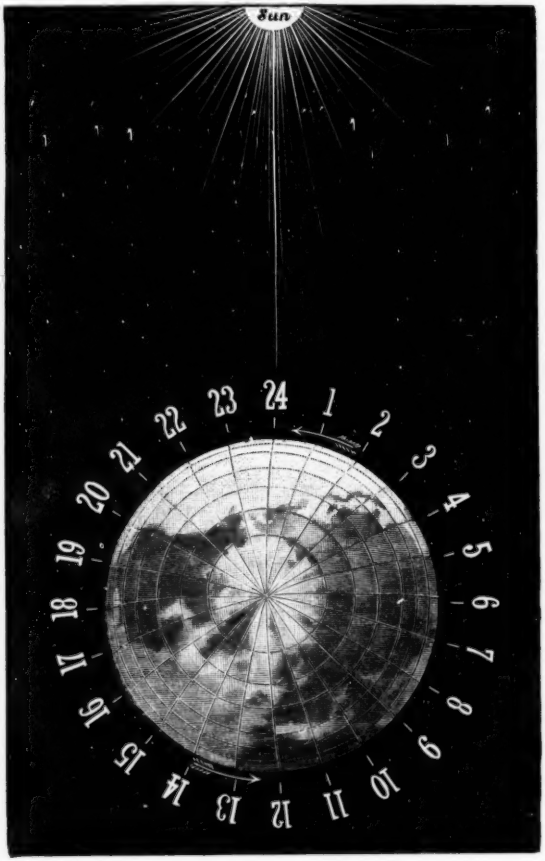
time changes with the longitude ; that each meridian has a separate and distinct time. Let us follow this theory out. Take a hundred or a thousand different meridians. All meridians meet at two common points, one in each of the hemispheres, the poles, so that at each of these points we would have a hundred or a thousand different "local times." This only requires to be stated to establish the impossibility and absurdity of the theory that in nature there is a multiplicity of "local times."

There is one time only, it is a reality with an infinite past, an infinite future, and continuity is its chief attribute. It may be likened to an endless chain, each link inseparably connected with its fellow links, while the whole moves onward in unalterable order. Divisions of time, like links in an unbroken chain, follow one another consecutively ; they have no separate contemporaneous existence ; they continue portions of the one time. Time remains uninfluenced by matter, by space, or by distance. It is universal and essentially non-local. It is an absolute unity, the same throughout the entire universe, with the remarkable attribute that it can be measured with the nicest precision.

The advance of civilization during the past half century has produced entirely new conditions in human life. Steam and electricity applied to communication by sea and land have done much to obliterate distance and bring all nations within one neighborhood, so to speak. Through force of circumstances we are now obliged to take a comprehensive view of the entire globe in considering the question of time-reckoning. We should not confine our view to one limited horizon, to one country, or to one continent. The problem presented for solution to the people on both hemispheres is to secure a measurement of the one universal passage of time common to all, which shall be based on data so incontrovertible and on principles so sound as to obtain the acceptance of the generations which are to follow us.

To effect any measurement there are two essentials : First, a starting point or zero. Second, a scale or a unit of measurement. The Washington Conference of 1884 has determined both of these. The zero is the instant of mean solar passage on the anti-prime meridian, which is 180° from the meridian of Greenwich. The unit is the smallest and most available measure of time which nature presents to us, the period occupied by a single rotation of the earth on its axis, and is denoted by two successive solar passages on the zero meridian.

Let us in imagination place ourselves in observation at the North Pole, free from local influences. We would find no sunrise, no sunset, neither east nor west, and every radius of direction would be identical. We have nothing given but the position of



the meridian establishing the time-zero. From this starting point suppose we divide the horizon into a series of arcs, each of 15°, making the total number twenty-four, and through the end of each arc we draw a meridian. The passage of the sun over the zero

meridian will indicate the commencement of the time-unit, which, according to the usage of centuries and the decision of the Washington Conference, is divided into twenty-four hours. At the end of the first hour the sun will be over a meridian which may appropriately be termed the first hour meridian; at the end of the second hour the solar passage will have advanced to another meridian, which may be distinguished as the second hour meridian; and so passing over the whole twenty-four.

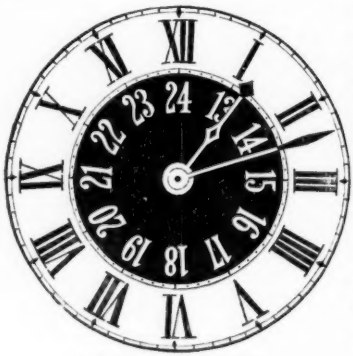
Reference to the diagram will make it clear that we possess the infallible means of measuring time with precision for ever. The diurnal rotation of the earth is marked by perfect uniformity of movement, and we know of nothing more certain than its continual recurrence to a given starting point within established intervals. Here then we have a great chronometer, common to the world, which can never go out of repair. Here provided by nature is a standard for the measurement of time which humanity at all places and in all ages may accept.

A method of reckoning has been evolved termed the "hour zone system," and the principle underlying it is, that on the passage of the sun on any hour meridian it is considered to be twelve o'clock noon throughout the zone to which that meridian belongs*; and that the notation in each zone is directly connected with the common standard of the world by an established relationship. It is obvious that if the notation in the several zones be directly connected with the world's standard, there will be a complete and systematic identification in the notation of each of the twenty-four zones. There will be differences, but the differences will in every case be known, the gradations being the invariable multiple of one hour. Throughout the globe there will be complete synchronism in the minutes and seconds. For example: When the reckoning is described in the tenth zone as 6 hours, 25 minutes, 30 seconds, in the eleventh zone it will be 5 hours, 25 minutes, 30 seconds, in the twelfth zone 4 hours, 25 minutes, 30 seconds, and so on, each successive zone differing in its notation by an exact hour. The only departure from complete uniformity will be found in the nomenclature of the hours, but the numbers of the hours being governed by the numbers of the hour meridians, reference to the common standard will at all times be simple and direct.

* A time zone or section is considered to extend seven and a half degrees on each side of an hour meridian, but the limits of each section will be governed by local circumstances.

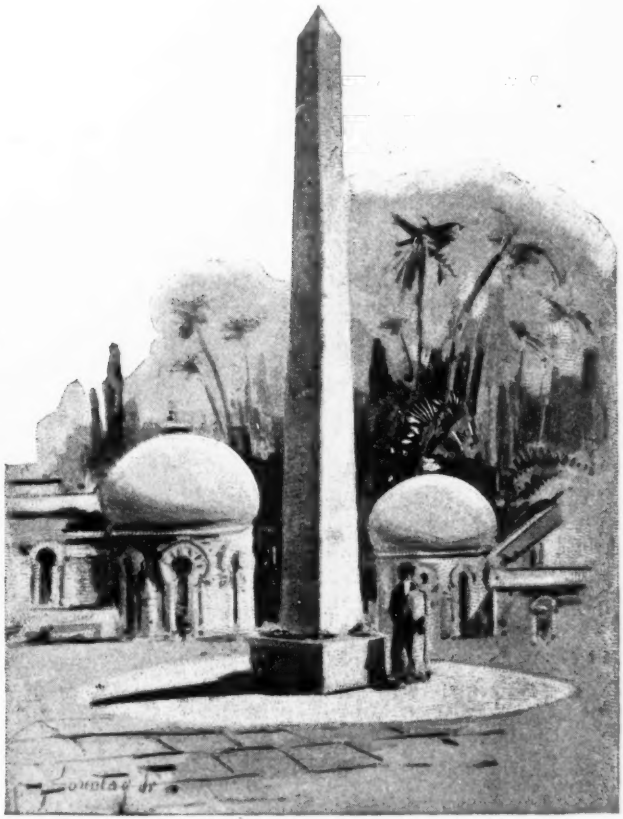
The hour zone system commonly known as standard time reckoning has now been in use throughout North America for seven years, and in the Japanese empire for two years. In England, Scotland and Sweden, the reckoning is in accord with this system. In Austria, Hungary, Germany and Belgium, by all accounts it is on the eve of adoption. Wherever it has been introduced, it has resulted in giving the greatest satisfaction.

Another important although secondary reform in regulating the reckoning of time throughout the world, is to abandon the division of the day into halves, these halves being subdivided into separate sets of hours, known as *ante meridian* and *post meridian*. The proposal is to follow the recommendation of the Washington Conference with respect to the "universal day" (the world's standard unit of time) which the representatives of all nations present determined should be subdivided into a single series of hours numbered from zero to twenty-four. The old custom of counting the day by halves has no more to recommend it than dividing the months into halves, a custom which prevailed in Europe before the fifteenth century. Each month of thirty days was divided into equal parts; each month of thirty-one days into a first part of sixteen days, numbered one to sixteen, distinguished by the word *intrante*, and a second part of fifteen days numbered in reverse order fifteen to one and known as *restante*. But the division of the day into two sets of twelve hours similarly named has positive disadvantages. In these days of railways the possibility of error is increased by it, and this is no light consideration. In the printing of time-tables and in giving and receiving train orders, a mis-print or misapprehension of a single letter may cause a mistake or mishap; while the degree of uncertainty which in some cases exists may lead to confusion, and confusion not infrequently results in dire consequences.



A CLOCK-FACE MODERNIZED.

The 24-hour notation removes all doubt, and assures safety. The change from the old custom is easily effected, and without



MARKING TIME BY THE NEEDLE'S SHADOW.

danger. Experience has established that time-pieces now in use can readily be adapted to the new notation by inscribing on their dials the afternoon hours, in some such manner as the diagram indicates. Hours having a lower number than twelve are known to belong absolutely to the first part of the day; those having a higher number to the afterpart. The new notation is now in use on all the railways within the Indian empire and in China. It has been widely employed in Canada for four or five years, where it continues to give increased satisfaction. According to a report submitted at

the last annual meeting of the American Society of Civil Engineers, there is every prospect of the change being made on all the railways of North America at an early day. The same report points out that while at the beginning of 1890 the 24-hour notation was in use on less than 4000 miles of railway, before the year closed it was permanently adopted on more than 20,000 miles.

If we consider the lapse of years exacted and the difficulty of the effort to effect some of the reforms in time-reckoning to which allusion has been made, we may well be surprised that so much has already been accomplished towards this final reform. Only a few years ago the proposal to interfere with the time-honored usages, whatever its necessity, was received with derision. It soon became obvious, however, to men of broad and advanced views, that great changes in time-reckoning, and time notation, would soon be demanded as requirements of the new conditions of human life. The Congress of the United States intervened, and on the call of the President a conference of all nations was held at Washington in 1884, when the subject was first authoritatively considered. Congress is again taking action by entertaining a measure recently introduced to legalize the changes already effected and contemplated.

In 1878 when an earnest attempt was made to bring the subject of "time reform" to the attention of the British Association for the Advancement of Science, it was looked upon as pure utopianism, and a hearing for it could not be obtained. To-day the British Government, ordinarily conservative in ancient usages, has forwarded to the governments of every British possession around the globe the recommendations of the highest scientific authorities in its service "with a view to the adoption of the hour zone system in reckoning time generally, and of the 24-hour notation for railway time-tables."

In Canada the reform has made very substantial progress, not alone in practical adoption and very general public approval, but particularly in the estimation of leading and influential men who are in a position to render the movement substantial aid. A bill has already been proposed for presentation to the Canadian Parliament, now in session, which is intended to legalize the reforms in time reckoning which have been adopted throughout the Dominion; and one of the Ministers who is very earnest in his advocacy of the reform, will of course give the measure his cordial support. Its passage, therefore, may be said to be assured.

In Germany the movement has also assumed considerable proportions, and now gives promise of taking practical shape at an early date. Almost the last speech delivered in the German Reichstag by the remarkable General Von Moltke, who has just passed away, was devoted to this subject. As late as March 16th, though past the point of four-score years and ten and rich in wealth and honors, he delivered a long and very able speech in advocacy of the reform. This is, indeed, a remarkable occurrence; significant alike of the ardor and vitality of the man, and of the importance of the reform which invoked his aid. Old age often stands a barrier in the path of progressive reforms, but here is an exception to the rule as admirable as it is rare.

The rapidity with which advantageous changes are carried in the United States, would seem to indicate that here is a field offering unusual opportunities for the speedy introduction of proper methods of time reckoning. The splendid record of the movement for ballot reform furnishes a striking illustration of what can be accomplished in a remarkably short time; and the universal approval accorded to the system of "standard time," adopted by the railroads a few years ago, shows how ripe is public opinion for the further time reform here outlined. Indeed, all the conditions seem to be ready and waiting for the men of activity, earnestness and influence who will take the movement in hand and carry it forward to success.

THE SPLENDID RECORD OF THE ELECTRIC RAILWAY.

By Frank J. Sprague.

ALTHOUGH the earliest practical proposals for electric railways were made almost simultaneously in Europe and America, their marvellous development and present importance in the industrial world are due, until very recently, to American enterprise; and a description of the experimental and commercial work in this country will most fairly illustrate the wonderful character of its growth.

The first serious proposal in the United States for the operation of an electric railway motor by current through the rails was made about twelve years ago by Stephen D. Field; one of the earliest private experiments was made on a track at Menlo Park by Edison in 1880. The Electric Railway Company of the United States, which represented the combination of these interests, exhibited a small railroad in 1883 at the Chicago Exhibition, and in the same year Daft made experiments at Greenville and Mt. McGregor. A year later small roads were built and operated by Daft at Coney Island, and in Boston at the Mechanics' Fair; and in 1885 the same inventor opened the first regularly operated line in the United States at Baltimore. This line has since been abandoned. About the same time Adams experimented in St. Louis.

In the winter of 1882–83 and in the fall of 1883, Vandepoele, who has been an active pioneer in railway work, operated experimental lines in Chicago, and in 1884, and subsequently, he operated an exhibition line at Toronto and Windsor; afterwards he equipped a number of roads, of which the one at Montgomery, Alabama, was one of the most notable. The central station plant of this road being destroyed by fire it stopped operation.

In 1884 experiments were made by Bentley and Knight with a conduit system at Cleveland, and the writer exhibited special motors at the Franklin Exhibition in Philadelphia. In 1885 and again in 1888, the Daft Company experimented on the New York Ninth Avenue Elevated division. In 1886 Henry experimented with street railway motors in Kansas City, and in the same year the

Edison–Field interest revived experiments in elevated railway work, but these were soon abandoned. About the same time the writer, aided by Edward H. Johnson, to whom the present success of electric railways is largely due, experimented on the 34th Street branch of the New York Elevated Railroad. Two twelve hundred pound motors, each geared directly to the axle of the single truck, propelled two elevated cars up the maximum grade, and many experiments were made to demonstrate methods of electrical braking. This work was suspended for lack of money, and because of the increasing importance of street railway work.

In 1888 Field resumed temporary experiments on the same road. In 1887, Sprague in New York and Boston with storage batteries, and at St. Joseph, Missouri, with an overhead line, following out the practical features of the elevated railroad motor experiments, began street railway work. In the same year the Julien Company began experiments with storage battery cars.

During the period thus outlined there were other experiments started in a small way, but they were not of serious moment.

Such is a brief resumé of the work done in this country during the first seven or eight years of the twelve which have elapsed since the earliest crude suggestions of a working system. Nothing is so marked as the varied character of this work, all of which may be termed experimental, as will be seen from a brief statement of the characteristics of these various operations.

There were two methods of getting the current. In one, that operated by the storage battery, the car received its charge at a central station and acted as an individual unit. This may be called a system of indirect supply. From the time of its first introduction this has offered a most tempting solution of the problem of surface transit, because while each car maintained many of the advantages of an electric system, it was an independent unit not ordinarily dependent upon a general accident to an entire system. The other was a system of direct supply. In this the current was delivered to the line from which the cars, as they moved along, derived the current. The forms of conductors were numerous. Sometimes the main tracks were used as a complete metallic circuit, each rail being insulated from the ground. In other experiments the tracks were used as one part of the circuit with an insulated centre or side-rail as the other part. To be clear of street obstructions one or both conductors were at times carried in a conduit ;

then again, one or two wires were carried over or alongside of the track, affording a ground or rail return, or a complete metallic circuit, the current being taken from the wires by a travelling carriage flexibly connected with the car.

The connection of the motor to the driving wheels was attempted in a great variety of ways, and nearly every mechanical device possible was used. Generally the motors were carried either on a separate motor car or upon the car body, and connections made with the wheels by means of round or flat ropes, or belts, sprocket chains and wheels, or friction apparatus, with various tightening devices. In one experiment the motor armatures were loosely sleeved on the car axle and connected by means of gears to field magnets rigidly secured to the axle boxes. In another case the motor was hung between the axles and connected to the wheel by an outside connecting rod like a steam locomotive.

There was no common standard of electric motive force, which varied from thirty to one thousand volts, nor even similarity in motor circuit arrangement, the motors being sometimes operated in multiple with each other with fairly constant potential and variable current, sometimes in series with variable potential and constant current, and sometimes in a combination multiple series arrangement.

A fair description then of the electric railway situation in 1887 would be that it was chaotic. Every one of the experiments here touched upon have been abandoned in their earlier form, either because of the development of better machines, more practical methods, lack of financial support, or because they were ill-timed. Especially is this last reason true of the elevated road experiments, which were attempted while the more urgent and commercially important street railway work was in its infancy and the whole science of dynamo and motor construction was undergoing a most rapid evolution.

In 1887 then, a hopeful band of enthusiastic electric railway pioneers looked back over the world's record of a dozen electric railways. They were poor in pocket, struggling against cynicism and ridicule, but were buoyed by faith in their work and encouraged by the predictions of a score of early workers who had handed down a record of their labors. Street railway men were disbelievers, car builders cynical, engineers skeptical, capitalists pitiful, and electricians themselves only faintly realizing the

commercial possibilities or the practical difficulties. A motor was regarded as a fine and delicate piece of machinery, to be carefully housed and tenderly protected. It had a fear of water and a delightful uncertainty of operation. Its construction was crude, its design unsatisfactory, its functions mysterious and the vagaries of the electric current were many and surprising. To put this delicate and erratic machine under a car, exposed to dust and moisture, was indicative of insanity; to connect it with a driven axle by gearing, an insult to mechanics; and to govern two or more of such machines with fixed brushes, out of sight, and with a controlling device in the hands of an unskilled man, was to juggle with the devil. To accentuate the waywardness of the current by grounding one circuit with a high potential difference, was surely flying in the face of Providence. To operate under the ordinary condition of street service was deemed impracticable; to attempt to mount over a six per cent. grade would be to lose one's reputation; and the operation of a number of cars over a long distance on the multiple system was thought to be commercially prohibited. Four hundred and fifty volts potential threatened unknown terrors of torture and death; the bare overhead wire promised unending conflagrations; while the rail circuit with mud, snow, and ice, was an electrical impossibility.

That all this has now been changed, and that these dire predictions are mostly unrealized, is due to many causes. In the years 1887–88, influenced somewhat by the then rapidly developing stationary motor work, a movement was inaugurated which was the precursor of the present development of electric railways—a development which has been one of the most rapid and remarkable in the industrial field. Two roads, differing materially in character, but both overcoming difficulties of grade and curves which commanded widespread attention, were opened about the same time. One was the Observatory Hill road at Allegheny City, Pa., put in by the Bentley and Knight Company, and operated partly by a conduit and partly by an overhead metallic circuit travelling trolley system. The other was the road opened at Richmond, Va., in February, 1888, by the Sprague Electric Railway and Motor Company, presenting conditions of length, grade, curves, road-bed and numbers of cars to be operated, which if successfully overcome would mark a new era in electric railway traction. This road had twelve miles of track, twenty-nine curves, numerous grades with a maximum of ten per cent. and a road-bed of execrable character.

It had its vicissitudes and its victories as well. Forty cars were operated, and no less than twenty-two simultaneously at one end of the line.

The distinctive features of this road may be briefly stated as follows: A working conductor carried over the middle of the track supplied at intervals by a main conductor running alongside the street, which in turn was supplied by feeders from the central station; a multiple arc system operated under a standard potential of about 450 volts; current taken from the working conductor by a grooved trolley wheel supported on an arm having a universal movement and carried in the centre of the car; a dual motor equipment, each motor being centred at one end on the driven axle, to which it was geared, and flexibly supported at the other end; operation of both motors with fixed brushes and from each end of the car. Of this system Mr. Franklin Leonard Pope recently said: "Many of the characteristic features at that time designed and introduced have practically become standards in the modern system and are found in nearly every one of the thousands of cars now in service."

However that may be, this road (which cost the electrical company $160,000, the larger portion of which was lost) was the first great system operated by electricity, and the difficulties overcome and the problems solved forever settled the supremacy of electricity as a motive power. The development which in the past few years has followed the inauguration of the road has been unprecedented, and has been largely aided by the adoption of electricity by the great West End system of Boston, and the almost equally large system of Minneapolis and St. Paul. In each of the latter cases the adoption of electricity was a decided victory over the cable.

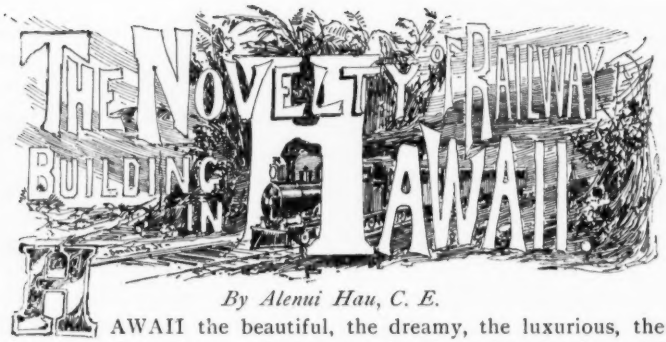
There are now in operation or under contract on the general lines laid down in Richmond, not less than 325 roads in the United States, England, Germany, Italy, Australia and Japan; requiring over 4000 cars and 7000 motors, with 2600 miles of track; making a daily mileage of not less than 400,000 miles; and carrying three quarters of a billion of passengers. Nearly a quarter of the entire street trackage in the United States is electric, about two-thirds horse, one-sixteenth dummy, and one-twentieth cable. Grades of 13 and 14 per cent., distances up to 6 miles from the central station, speed as high as from 25 to 30 miles an hour for single cars, trains of from one to four cars, characterize the electric operation. Not

less than 10,000 people are employed on these roads, yet not one life has ever been lost by reason of contact with the standard potential adopted. Fifty millions of capital invested in the street railway work alone, and a present annual business of not less than from eight to ten millions of dollars by the manufacturing and contracting electric companies, show the importance of this work.

But the field of the electric motor is not confined to street railway operations. Already its future in city and inter-city rapid transit is assured, because it is the only possible means of successfully and economically operating a large number of units under the most satisfactory method of construction which shall really answer the demand of rapid transit, and that is the underground tunnel. One of the most striking examples of this method of operation and of the great value of the electric method of propulsion, is the new Suburban and South London Electric Railway opened in November last. This is a double tunnel road, three and a quarter miles long, running under the Thames River. It was originally designed as a cable line, but was subsequently changed to an electric road, and is now successfully operated as such with an average running speed higher than that of the elevated railroads in New York. The electrical equipment of this road marks the first instance in which the motor armature has been placed directly upon the driving wheel and moves at the same angular velocity.

Probably nothing illustrates the change of sentiment with regard to electric traction so forcibly as the introduction of an overhead wire system into Florence, Italy, into Tokio, Japan, and the proposed equipment of such a road in Shanghai, China.

The introduction of electricity has had an influence in many ways which can now be but briefly touched upon. The cost of motive power has been materially lessened; the running speed and passenger receipts materially increased. The cleanliness of streets and the comfort and safety of passengers have been materially added to; stronger, more comfortable and luxurious cars are built, and larger and easier riding ones are coming into vogue. The road-bed both as regards rails and street conditions has been materially improved. Car stables have given way to splendidly built and appointed electric stations. The *morale* of employés has been raised; railway securities find a readier market; old roads which ran at a loss or with scant gain have become dividend earners; and new roads which were prohibited for horse traction are profitable and promising when electrically propelled.



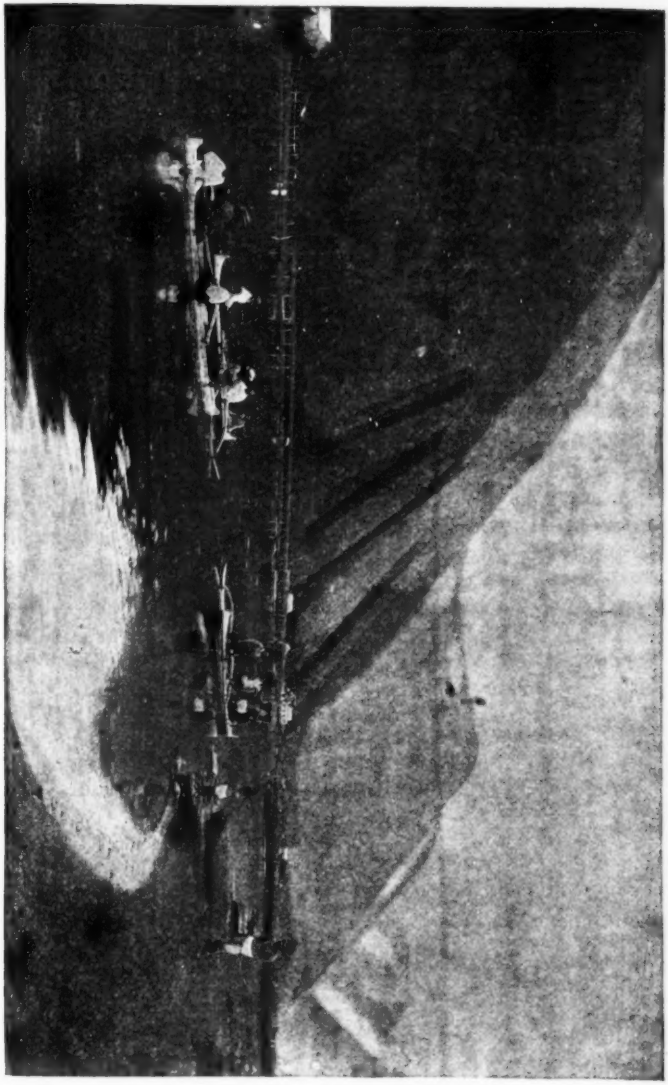
By Alenui Hau, C. E.

HAWAII the beautiful, the dreamy, the luxurious, the theme of the painter and the poet, has been invaded in rapid succession by the trader, the planter, the mechanic and the engine-driver. We would fain dwell upon the romance of the island paradise, but our present lot is to trim our most utilitarian pen and confine ourselves strictly to business.

The Anglo-Saxon intruders into this land of poetry, strict, matter of fact New Englanders as the first of them were, have not been able to avoid the kindling of sentiment within them. Hawaii is still beautiful; the stern necessities of commerce with the attendant ugliness of wharves, coal heaps, brick buildings and worst of all, telegraph poles, have not robbed her of her glories. Civilization cannot be accused of vandalism in the city of Honolulu. No offensive placards of quack medicines or vulgar exhibitions disfigure her gems of scenery, as they do on this continent. Her merchants and citizens have not only cleared away the tangled brushwood and dense jungle of the valleys, but they have dotted the whole plain around the capitol with artistic dwellings and gardens decked in perennial green, scarlet and gold.

HILO.—ISLAND OF HAWAII.

There is a kindling of more than sentiment under the genial influence of the tropical sun and the fanning of the gentle trade-wind. A spirit of friendliness, of welcome,



WAIPIO: ISLAND OF HAWAII.

of sympathy pervades the place. When visitors leave, the King's band give them a royal send-off with *volks lieder* from the Fatherland, old songs dear to the American, Englishman, Scotchman and Irishman, and always ending with "Hawaii ponoi," the national anthem of the Islands. Garlanded with brilliant flowers the visitors feel their bosoms swell as the *Australia* or *Alameda* backs slowly outwards into the harbor—and they remember it as a sweeter reminiscence of travel than they had ever known before.

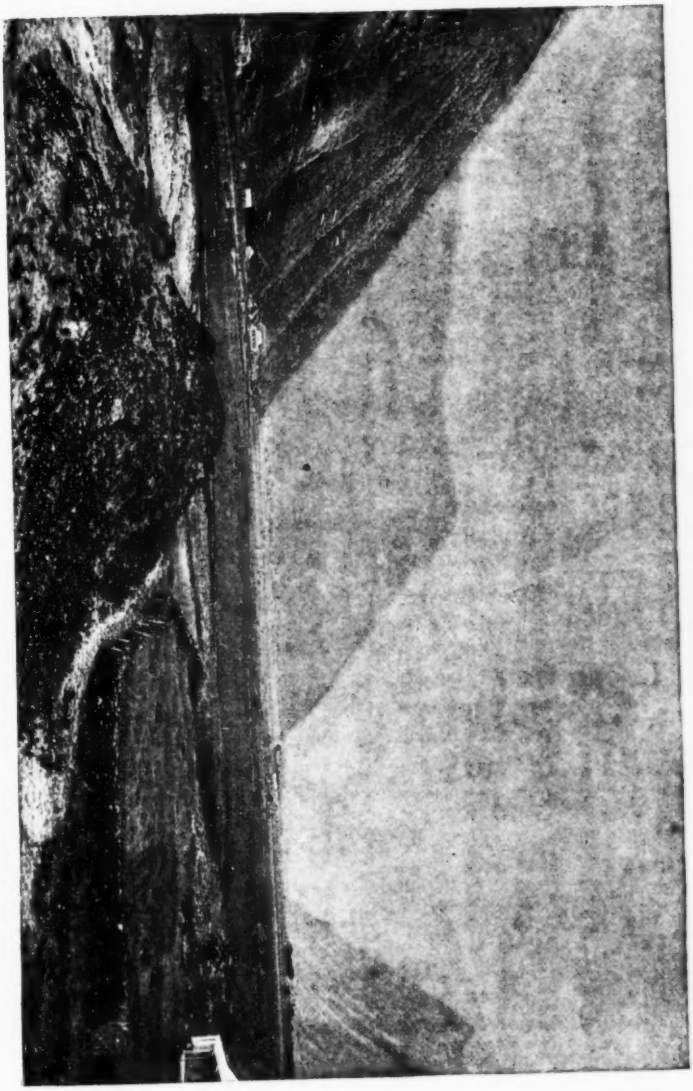
The citizens are loth to see the inroads of the "useful" upon the "ornamental." They bow to the inevitable but not without a groan. When fate decreed that the writer should introduce into the Hawaiian capital its first railway, he met a friend on his arrival whose acquaintance he had made on a previous occasion, one of the judges of the Supreme Court, who saluted him with the remark, "We are so glad to see you Mr. Han, but not to see your railway. Cannot they find something better for you to do than to tear up our beautiful avenues?"

As the work went on and street after street was traversed by the track-layers, one of the most influential of the citizens lifted up his hands in horror, saying: "You engineers are everywhere."

One day the news came that there was trouble on one of the branch lines, and on arriving at the place it was discovered that a wealthy citizen had driven in a stake opposite to his house saying, "Thus far shalt thou go and no farther." He said that he would spend two hundred thousand dollars to prevent the track from passing his house; and to prove his sincerity he belabored one of the Portuguese workmen with his umbrella.

But how things change! The road of which the knowing ones prophesied nothing but failure was opened on January 1, 1889, with a rush of natives hanging on to the open cars and struggling and fighting for a seat. Beginning with the populace it soon found patronage with the great and wealthy. My horrified friend was one

ROAD TO THE PALI—ISLAND OF OAHU.



WAIPIO—ISLAND OF HAWAII.

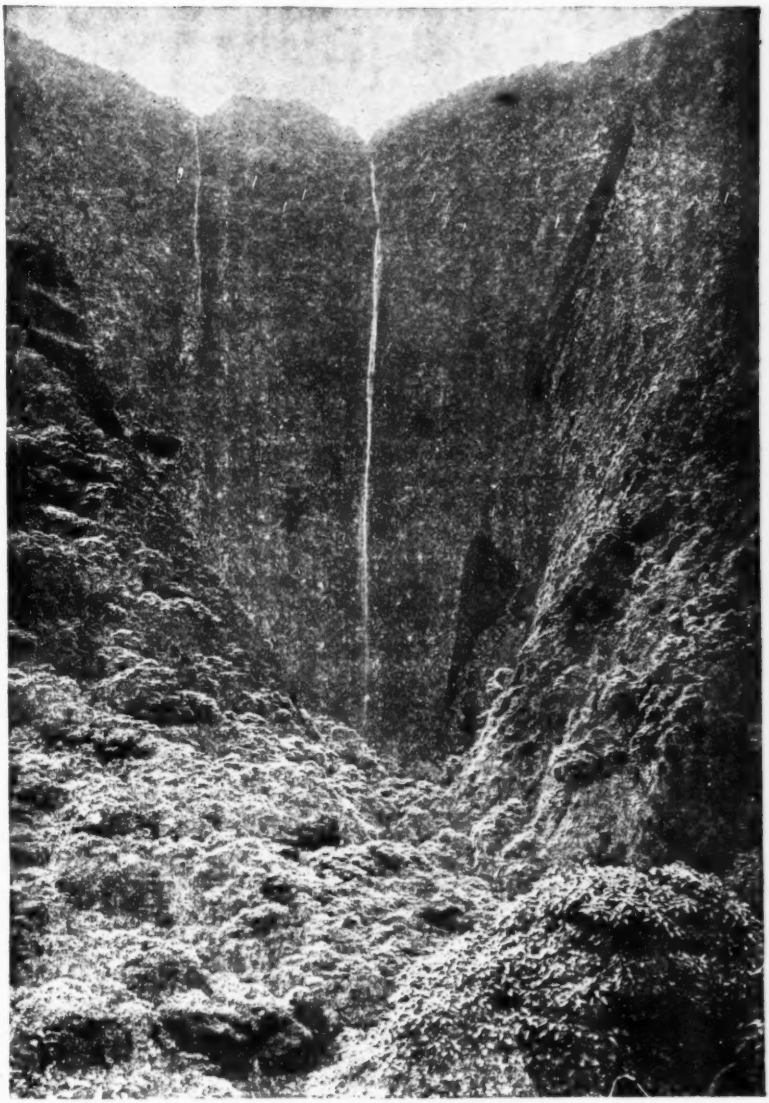
of the first to become a regular occupant of the car. His late majesty Kalakaua took an early opportunity of honoring the front seat and chatting pleasantly with the driver. A short while afterwards her royal highness, Liliuokalani (now queen) ordered by her chamberlain a special car to convey her and suite to her sea-side residence at Waikiki. Two cars were coupled and festooned with ferns and flowers. The finest span in the stables was hitched in and with festive song and twanging banjo the company of sable dignitaries was gayly conducted to their sea-side home.

The cars were of course all open and the seats were furnished with reversible backs. On the opening day it was amusing to see some natives apparently unaware of the way to reverse the seats, riding backwards. It turned out afterwards, however, that they were not

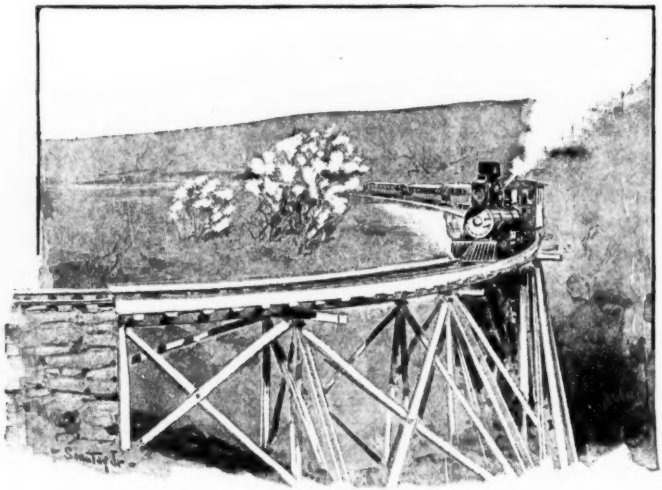
WAIKIKI.—ISLAND OF OAHU.

at all ignorant of the way to turn the seats, but they were spending the afternoon in riding up and down, and feared to rise lest they should lose their seats.

There is a feeling of good-humored mischief in the native mind towards the Chinaman, who by his thrift and diligence manages to wheedle the Hawaiian out of his possessions. The native respects the celestial's cleverness in money matters, but in all manlier qualities of physical prowess, agility or horsemanship, looks upon him as a duffer. The Hawaiian at once found out how to board or leave a street car when in motion ; but it was his delight to induce the Chinaman to try the experiment, and to watch the result, especially when the poor fellow was encumbered with parcels. Usually the



WAIPIO.—ISLAND OF HAWAII.



CURVE ON HAWAIIAN RAILROAD.

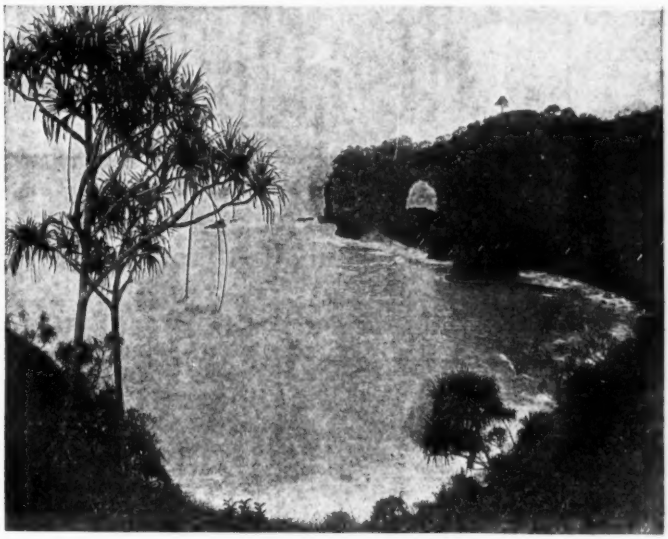
parcels and the Chinaman followed devious paths, all finally reaching the ground, whilst the native clapped his hands and yelled with joy.

I was once requested to reserve a special car for the undergraduates of the theological seminary to take them to the sea-side. The car was on hand when the reverend director came into my office in great perturbation. "Just like these Hawaiians," he said, "they are never to be depended on ; they have all disappeared from the college and I wish you to countermand the car."

"Impossible," I replied, "the car is on hand at the starting place and will have to take its turn and be paid for."

Just then the car came along, crowded,—not with graduates in sable, but with sable undergraduates. Knowing the car would have to start a mile back from the college, they had walked the mile in order to join it at the starting place and get the longest ride possible for their nickel.

Perhaps the greatest amusement was created by the young mules imported from California, which had to be broken in to the street-car work. Fine fellows they were, nimble as deer and sportive as kittens. They would sometimes act like bipeds and looking round towards the passengers extend towards them a friendly front foot ; but their cavortings were soon cut short by the prosaic necessity of keeping track.



NATURAL BRIDGE AT ONOMEA—ISLAND OF HAWAII.

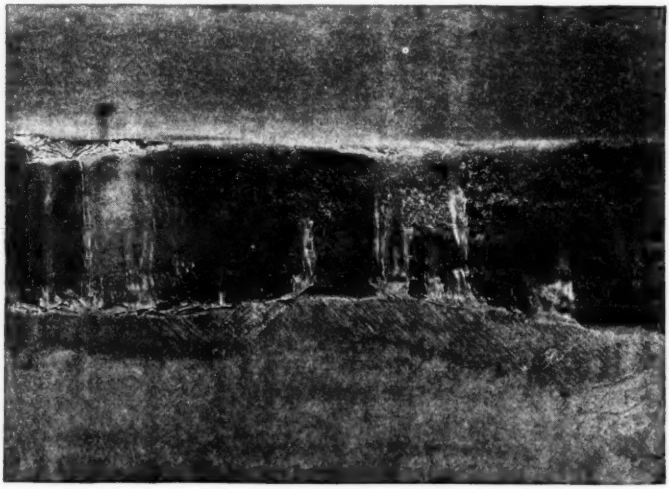
The city of Honolulu has now about 23,000 inhabitants, one-fourth of the total population of the Islands. There are now twelve miles of single track street railway with passing places arranged for a ten-minute headway. The main line runs parallel to the shore along a fine broad macadamized roadway commencing at the Kamehameha schools founded by the late Princess Pauahi who married Mr. Bishop the leading banker of the Islands. A very fine institution it is, in which the young Hawaiians can receive a good education of mind and body for next to nothing. The line passes the private residence of the present queen ; through the Chinese quarter and into the heart of the city, thence between the king's palace and the Government House, and continues through the best residential districts to the watering place of Waikiki. Here are the residences of the late king, the present queen, the Princess Kaiulani ; the race-course and park, and numerous handsome country houses of the wealthier merchants of the city. Just beyond Waikiki is the old crater called Diamond Head which is a useful land-mark to the mariners.

Other branch lines pass inland at right-angles to the main line, one of them close to the Royal School and Queen Emma's Hospi-

tal, the latter a beautifully-kept institution, the grounds of which are the especial care of the Hon. Archibald Cleghorn, the father of little Princess Kaiulani, and president of that institution.

Honolulu is abreast of the times as to the applications of electricity, though it has not yet been applied to the street railways. The Palace and the Hotel are supplied with incandescent light and the main thoroughfare with Schuyler arc lamps. The installation was made by the Thomson-Houston Co., the power being obtained from turbines worked by the same water which supplies the city.

The telephone is probably more universally adopted in Honolulu than in any city of the United States size for size. There are two rival companies who have cut rates until soda water stands are able to put in the instruments. All the marketing is done and all the daily scandal is talked through the telephone. Professor Tyndall has exhaustively proved that heat is a mode of motion, but in Honolulu it is exhaustively proved that motion is a mode of heat. Locomotion of the body produces high commotion of the blood, and under the influence of these electrical conveniences people use their legs as little as possible. The street cars and steam railroads are all started and organized by telephone and an electric railway is already the topic of the hour.



LAVA FLOW OF 1881.

HER MAJESTY LILIUOKALANI—QUEEN OF THE HAWAIIAN ISLANDS.

The street railway of Honolulu was shortly afterwards followed by a steam railway from the capital to the lovely lagoon called Pearl Harbor. It is at present about twelve miles in length but will probably be extended. It is already paying its way and a new plantation has been started at its terminus. Pearl Harbor consists of three arms of the sea with narrow inlets, commonly called the East, Middle and West Lochs. It is a pleasure resort especially for boating parties, and the air is so fresh and pure that the water-front sites, suitable for country residences are likely to become valuable. The construction of the line was easy, located as it is upon the coral flats which extend along that side of the island of Oahu. With the exception of a few cuttings through spurs of the volcanic mountain range, and some rather long embankments through rice marshes, the railway was a surface line. It is 3 feet gauge and handles a considerable business already. The industrious Chinaman had previously developed the marsh lands with rice and banana plantations with no greater facilities than his bullock-cart by land and schooner or whale-boat by water, and the railway will doubtless give him a fresh impetus.

Pearl Harbor may have a grander destiny and the railway prove a bonanza to its proprietors. The three lochs have a capacity and a depth for accommodating either the future navy of the United States or the present navy of Great Britain. A short stretch of coral reef forming a bar would have to be removed in order to give access to vessels of deep draught. The cost of this has been variously estimated at from $300,000 to $2,000,000, probably the first figures are nearer the mark.

When examining this bar in a cursory manner, it did not appear to be growing coral and from the large quantities of fresh water flowing through the channel, it is unlikely that it would be. A very small proportion of fresh water will prevent the growth of coral and several experiments with a water-tight bucket, opened and closed under water, have proved the existence of strong fresh water currents. The reason of this is that the heavy rainfall in the hills is carried away by natural underground conduits formed by fissures in the volcanic rock, and flows over the lower coral beds but under the alluvial slopes and so out into the harbor.

The promontories which divide the lochs are peculiarly suitable for warehouses because vessels of deep draught could lie alongside without dredging.

An agreement exists between Hawaii and the United States

under which the latter have the exclusive right to make and maintain a naval harbor at Pearl River. A protest was made at the time by the British commissioner upon the grounds of an international treaty which gave equal rights to all the signatory powers for the use of existing Hawaiian harbors, but Minister Austin contended that this was not included in the provisions of the treaty inasmuch as it was not a harbor at present.

The effect of the recent tariff alterations will test both the productiveness of the islands and the energy and enterprise of the settlers. Many concerns which have been built up on slender capital, long credits and high prices, will be seriously affected by the smaller returns of profit upon this year's and future crops. But the strength of Hawaii is in her generous soil and climate. With cheap labor, increased facilities of transportation, and labor-saving appliances, she will be able to hold her own without favors. What she needs most of all is to be brought into closer contact with the United States, and she would certainly be as valuable to this country as this country's alliance would be to her. The time for Great Britain to have annexed the islands has passed by. They would have been an excellent "rest and be thankful" between British Columbia and Melbourne, an invaluable mid-ocean link in the great Imperial Federation Scheme; but the American interests, social, political and financial, have reached so great a preponderance that we may expect some proposals for uniting Hawaii to the great Republic in the immediate future.

The present queen has not been hitherto credited with any capacity for government, although with considerable talent for intrigue. In the last insurrection which terminated fatally to several natives it is generally believed that the arch conspirator Robert Wilcox was on intimate terms with the princess and resided for some time at her house; that the arms were stacked in her pantry and the rebels started in a body at 4 o'clock in the morning from her doors. She was absent at the time and of course disclaimed all complicity.

The heiress apparent is now the little Princess Kaiulani, daughter of her late Royal Highness Like Like and the Hon. Archibald Cleghorn, but it is very doubtful whether the purple will ever grace her shoulders. She is being educated at an English boarding school, which she greatly prefers for the present to the allurements of Honolulu.

When the country is thrown open to republican push and

American capital is tempted there by a submarine cable, frequent and rapid steamship service and local facilities commensurate with the means of access, all existing rights and franchises will become very valuable; and for those who are given to speculation Hawaiian securities might well offer some temptations at the present moment.

In a succeeding article the introduction of railway enterprise to the development of the industries of Hawaii will be touched upon.

SHOULD THE STATES OWN THE RAILROADS?

By William T. Croasdale.

THE attitude of most railway managers and owners toward popular agitation for a radical change in railway policy and management, is simply that of stubborn resistance to an unreasonable demand. These people, in effect, say that the roads they control are their own property, and that the owners can be depended on to conduct their own business in their own way because they really have too much at stake to permit them to cripple the activity and interests on which they depend for profit. If the premises are correct this reasoning is sound, and the sufficient answer to all demands for a radical change in the railway policy of the country is that the system is good enough as it is, and the dissatisfaction with it mere clamor due to ignorance and largely inspired by demagogues. Those who accept this view logically refuse to discuss proposals for change and insist that there is no railway problem that demands public consideration. Nevertheless the great body of the people insist that there is a railway problem, and the result has been the creation of the Interstate Commerce Commission by Congress, and railway boards in many States. Every act creating any such body is a practical denial of the claim that railways are the private property of their owners, in the same sense that other things are private property.

This idea, however evolved, is a sound one, and it is really older, better established and more conservative than the opposing opinion that railways are the private property of those in possession of them. A railway is a public highway, and the idea that a public highway may be privately owned is a recent one that violates all the traditions of English-speaking people. The closest approximation to any such system in the past was that of the turnpike; but the turnpike never was truly the private property of the men who built it. They were given the power to collect tolls from all who used it, but they never had the power to exclude any who were willing to pay the tolls allowed by their charter for its free and equal use. The turnpike was merely a temporary device for securing the construction of good roads by private enterprise, generally with the distinct stipulation that the highways thus built should at some

future time become public property. They were at all times public highways, and never private roads. They were created by the exercise of the public power of eminent domain, not unfrequently supplemented by the aid of the public power of taxation, and there never was any question that the public would ultimately own them. When, in course of time, the progress of invention gave to the world a much more efficient public highway, there was no thought on the part of anybody of abandoning the established usages in the construction of the improved roads. The governmental power of eminent domain was as unhesitatingly used to acquire land for proposed railways, as it had been exercised in behalf of the creation of the earlier forms of public highways, and in many instances the charters for railways fixed the maximum tolls that the owners of the railway should charge those running vehicles over the road. In one instance, at least, in Virginia, the charter provided for the erection of toll-gates at specified intervals.

This theory that the railway is a public highway, is not left to mere inference. In many instances the right of State Legislatures to authorize the condemnation of land for railway purposes was legally challenged on the very ground that the proposed business was, in its nature, a private one, because others than the owners could not, in the nature of things, run their vehicles on the new form of road. In every instance the railway companies met this declaration with a denial, and insisted that their roads when completed would be open to all vehicles adapted to them, by whomsoever owned, and it was this contention, and this alone, that enabled them to obtain in New York and New Jersey decisions that the right of condemnation could be lawfully exercised in their behalf. The decision in New Jersey in favor of the Camden and Amboy Railroad was so explicit in this matter that it would, if now enforced, put every such roadway in that State back into the hands of the public.

It is the radical departure from this early and wholesome view of the question that has caused all the troubles between the railways and the people that have followed and led to annoying and futile restrictive legislation. Such legislation must always be futile if the claim of absolute private ownership in a public highway is permitted to stand. In that case it ought to be futile; for if the railway corporation owns the railway just as a man owns his house, no interference with its conduct of its own business can be justified except that warranted by the police power of government. The remedy for existing evils and complaints is not socialistic legis-

lation, confessedly interfering with private business, but a return to established usage concerning public highways. The proposal by Mr. Hudson some years ago that railways shall practically be made iron turnpikes, failed to command the attention it deserved simply because the proposal did not go far enough. The turnpike idea is out of date. The people demand common roads, that shall be better than the old turnpikes. They must demand that all highways shall be publicly owned. The true solution of the railway problem lies in the State ownership of public highways, and not in the suggestion that the whole vast transportation business of this country shall be undertaken by the Federal Government. The demand for the latter would not be persisted in if the people could be brought to see what could be accomplished through the public ownership of the track and road bed.

The objections to the ownership and management of the transportation business of the country by the Federal Government are numerous and well founded. In the first place that government has no constitutional power to engage in any such business. More important still it ought not to have such a power, and it will never receive it through the voluntary vote of States wisely jealous of their rights and determined to conserve the existing guarantees of local self-government. Aside from this consideration, again, there are good reasons for objecting strenuously to any such increase in the "patronage" of Federal officials as would be involved in the transfer of the control of the whole railway system of the country to a bureau or department at Washington. Certainly nothing of the kind can be seriously thought of by any one until we have had the benefit of the experience following the transfer of the telegraph system to the Post Office Department. That will require no constitutional amendment and the change is sure to come, because telegraphic messages are mere substitutes for letters and, if we are to have a post office department, it ought to have charge of the whole business.

None of the constitutional or other objections to the Federal ownership and operation of railways applies to the State ownership of these highways, open to all under proper conditions and operated by private enterprise. That will be a mere reassertion of a jurisdiction exercised from time immemorial over other kinds of public highways and it will require no extension of governmental powers, though it will, of course, involve the commissioning as public officers of certain railway employés, now connected with the

departments of despatching and inspection, on which railway companies depend for the safe and regular running of trains. If these departments are efficiently manned it will not make the least difference who owns and operates the trains of cars running on any railway. Here and there, as in the case of short roads carrying an enormous traffic between great cities and their suburbs, difficult problems may present themselves that may require an extension of the police regulation tantamount to actual governmental operation, but such instances do not in the least controvert the general rule that, with proper public regulation, competing companies can just as readily conduct the modern business of transporting passengers and goods over modern highways as competing lines of ocean steamers can thus conduct the ocean carrying trade. This will not involve the ownership of a train of cars by each individual traveller any more than a determination to cross the Atlantic now necessitates the purchase of a ship. The mere fact that men could combine to buy or rent cars would keep prices for freight and passage down to figures sufficient to assure a fair return on the labor and capital regularly engaged in the transportation business. Take the wholesale dry goods men of New York as a case in point. Those engaged in it for years have complained of a classification that subjects their goods shipped west to an exorbitant freight. Can any one suppose that if these people had the right to despatch to Chicago a train owned or hired by themselves any person or company engaged regularly in the business of transportation would not promptly offer to carry their goods at a price somewhat lower than the cost the shippers would be put to by engaging in a new and, to them, untried enterprise? In this, as in all other business, we should see that free competition reduces prices to what they should be, and combinations to monopolize are not permanently possible where there is no artificial interference with production or exchange.

One does not need to argue the matter as an abstract question. Right here in New York we are doing the very thing suggested. The Erie Canal is owned by the State but it is free as any natural water-course to any individual or company desiring to run boats over it. The result is the carrying of freight at the lowest price consistent with fair compensation for the labor and capital employed in the business, and the keeping down of railway freights by the canal's competition. If the New York Central Railroad were similarly owned by the State it could be used by competing com-

panies and persons, just as the Erie Canal is now used. There is no difficulty inherent in the suggestion that cannot easily and speedily be surmounted. It is true that there are stories of jobbery connected with the State management of canals, but they do not allege any abuses greater than those attaching to all other departments of administration, and there is no question as to the advantages the boatmen and the interests they serve derive from a free canal. The purification of a public service is a political duty that the people will perform whenever they think the effort worth making, and the question is one of administration, not necessarily connected with the discussion of the proper functions of government. Otherwise there would be a fair argument in favor of abolishing government for the purpose of getting rid of inefficient or corrupt public servants—burning the house to get rid of the rats.

One thing is certain ; no petty pilfering by public officials can entail on the public such loss as it has been subjected to by the present railway system. Put aside all questions of overcharging and merely calculate the cost of useless railway building, and this becomes uppermost. Here in New York State is an example of the loss and inconvenience entailed by private ownership of public highways with which the writer happens to be familiar. There starts from Port Jervis a short line of railway terminating at Monticello in Sullivan County. It was built with money borrowed by the townships through which it runs, on which the people of those towns are still paying interest. Of course it is not owned by the people whose money built it. It formerly connected with the Erie road at Port Jervis. A quarrel between the Erie and the Ontario and Western companies put this little road in the hands of the latter. The people of Port Jervis thereupon put their hands in their pockets again and built a branch connecting this road with the Ontario and Western at a point geographically as far west as Monticello. The result is that people desiring to reach the last named town, which is a summer resort, must first go twelve or fifteen miles further west than they want to go, to Summitville on the Ontario and Western, then run east nearly back to Port Jervis and then go west again ten or twelve miles to Monticello. Everybody is inconvenienced, twelve or fifteen miles of useless road have been built and the operating company makes little, if anything, out of the operation, though it holds on to the road in the hope that it may be extended so as to give it a line to the Pennsylvania coal fields in competition with the Erie.

Such a condition of affairs could not arise under a system of State ownership. If the people of Monticello wanted to come to New York they would only have to organize a company with capital enough to buy a few locomotives or cars. There are already companies from which they could hire cars if they did not want to buy them. They probably would not even have to do this, for some organized transportation company would be likely to run one or two trains a day over the Erie and the branch road to Monticello, if the traffic warranted it. If such a company attempted extortion, however, the Monticello people could start their own train in competition. The fact that this could be done would prevent any necessity for it. Had such a system prevailed the Port Jervis people would only have had to buy or rent some cars and locomotives and use them so long as necessary instead of throwing away money in a permanent investment in a needless twelve or fifteen miles of roadway. Money would have been saved and the public convenience and prosperity promoted by the public maintenance of public highways open to private operation. Lastly, any demand for coal along the line of the Ontario and Western would be met without so much as a thought of building a needless road parallel with the Erie. There are thousands of such instances, and I merely quote this one because I was at one time sufficiently inconvenienced by the existing arrangement to inquire somewhat carefully into its causes. All railway men complain of the waste of energy in building useless competing roads. Such waste would be largely avoided if the competition sought could be had over existing roads.

The re-establishment of the public ownership of public highways would do away with the demand for most of what is known as railway legislation. The supervision over common carriers that the State has always exercised might continue, but most of the attempts to regulate the railway business by boards and commissions would cease. Free competition would actually accomplish objects sought in vain through legislation and the long and short haul difficulties would disappear. No one would carry freight at a loss for any distance and if any one charged too much for a service he would soon be underbid. The mere fact that any community able to raise sufficient capital to buy or hire some rolling stock would be able to protect itself against extortion, would afford even the individual shipper all the protection he would need.

So far as the Federal Government is concerned it would have no other concern than to see that free trade between the people of

the several States shall not be interfered with by discriminating charges against cars passing beyond or coming into a State. Legislation of this kind might be necessary, and it is clearly within the constitutional powers of Congress. No enlargement of Federal powers would be required while the separate States would not be asked to exercise any functions that they do not now exercise as to some kinds of highways. Furthermore, there need be no waiting by one community for another. The State of New York, for instance, has not exhausted its power of eminent domain. It can just as easily condemn the two strips of land between this city and Buffalo now held by the Vanderbilts and others as it did when the same strips of land belonged to numerous private owners. There is no difficulty whatever in acquiring two or more good highways from New York Bay to Lake Erie and, having acquired them, the State would doubtless find those now engaged in the business of transportation eager to use the highways for such traffic, though no longer able to monopolize them. They have too much money invested in rolling stock to let the latter lie idle. There need be no socialistic legislation, no vast concentration of power at Washington, no new departure that will scare conservatives. All that is needed is a simple change that will put railways in the position that they were intended to occupy, and which, but for the stupidity or worse of some modern judges, is the only position that they can legally occupy, that of public highways the use of which cannot be monopolized by any person real or artificial. This is the easy way and the right way, and whenever the people who demand a radical reform in the existing system come to see and recognize this, some State will resume the possession of its own highways, and the movement once begun will go on until there is no longer a railway problem such as that now existing to vex the people and encourage foolish and futile regulative legislation, which has failed and always must fail, for the obvious reason that at present the railway companies are stronger than the States, and no agency that any State can create can rightly be stronger than its creator. So long as the States fail to assert their powers and perform their duties no board or commission can in the long run fail to become the creature of the corporations it is designed to control.

ENGINE-ROOM CHAT.

By Col Loquial.

JIMSON had a circus in his boiler-room the other day. Gauge-glass gave way. "Two bodies can't occupy the same space at the same time." The body of steam and hot water was scarcely more active than Jimson was, but in some respects more imperious, and so Jimson literally "retired from active circulation"—for a time at least. Now, why in common sense didn't he have an automatic attachment in the fittings, by which the outlets would be closed the instant the balanced pressures were unbalanced by the breakage of the glass tube? Jimson was considerably demoralized, and when he took his shirt off he took some of his skin with it and had to be molasses-and-floured over quite a respectable area. The thing might have taken the eyes out of him if he had been looking at it when it let go of itself. As it is, Jimson takes his meals standing and don't seem to relish his wife putting her arm around his waist.

* * *

Maggs bought a job-lot of coal on Friday. He now thinks he got some experience in the way of a chromo thrown in "free gratis for nothing." The coal had been unsheltered for quite a while—about a year—and somehow or other it fails to enthuse the water as earnestly as the other coal did. It takes about 14 tons a day to run his plant, instead of 11½. Maggs made on the back of an envelope some figures which, being interpreted, mean that if the old coal cost him $4.20 delivered and put in, the new lot should have cost only $3.45 to be just as cheap. As he paid $3.75 for it he thinks that he is like the label on the whiskey bottle—not in it.

Leached coal is no good.

* * *

Baring & Co. sent my friend Turner some cheap Babbitt last month—eight pounds for a dollar. This on Sees Bros. recommendation. Sees certified that one pound of Baring's Spread Eagle Babbitt lasted him as long as three of the True & Co. brand. Figuring up his oil bills since he re-poured his boxes with the Spread Eagle metal, Turner finds that he has saved ninety cents in metal at an expense of six dollars and thirty cents in oil. He hasn't calipered his journals yet. I think that when he does he will come to the conclusion that it is cheaper to rub off good Babbitt than to wear down his journals and pay extra oil-bills for the privilege.

* * *

I was in Sordoff's place the other day and we got talking about belt-tighteners. Sordorf believes in them. I don't. Mind you, I'm talking about tighteners, not idlers. Idlers are "bay horses of another color." An idler is a pulley that practically puts no strain on the belt; just quietly takes up the bulge of the slack fold, and wraps it rather more than it otherwise would reach—around the smaller pulley preferably, as that is the one which needs it most. A tightener is something that puts extra strain on the lacings and on all the bearings. An idler does not necessarily add anything to any hurtful strain about belt or bearings. The idler enables the belt to drive more, because it increases the difference between the tensions on the tight and the slack fold. The tightener generally enables the belt to drive more, by increasing the tension on the tight side, and thus effecting a greater difference between the two tensions.

Well, Sordorff was so everlastingly sure that the tightener was the cure for all ills that belts are heir to, that he wanted me to bet him a hat that there was no increase of friction, to speak of, by its use. We tried it by rigging up a brake on a shaft driven by a belt on which we could put a tightener or not, just as we pleased. Then we hitched a little engine up to that load and nothing else, and took a few indicator cards with the brake on and with

the brake off, using an idler and no tightener; next, doing the same thing with the "cure-all." The result was to prove even to Sordoff that the tightener increased the friction about 20 per cent. for any given net drive. Of course there was more wear and tear of journals and bearings with the tightener than with the idler, and the belt was strained more. Sordoff thinks differently now.

* * *

The average architect don't know it all. The latest fool thing that he has done is to stick an artesian well, or rather a drive well, right down beside the foundation wall of one of the finest buildings in Jaytown, with the result of cracking things all on that side of the edifice. You can't rest a foundation on wind, and a drive well of good moral habits and strict attention to business will move things around in its immediate vicinity.

* * *

Jack Assman built a chute from the fourth story window of a looking-glass factory right across the court from me. It was to carry down the wet sand used in grinding and bevelling the glass plates. He made it of No. 12 galvanized iron, two feet in diameter, circular in section, and hung it in the angle of the building by three-quarter inch round irons. I gave that chute a wide berth as soon as cold weather set in. Events proved I was right. The wet sand froze in the chute and it gradually filled up, until one fine morning it just divorced itself from itself about two-thirds of the way up, and came down with what the newspaper reporters used to call a "dull, sickening thud." What is left of the part that fell is not worth straightening. No junkman so poor and lowly that he would take it away as a gift.

The owner is going to have a quarter inch tank iron chute, and fasten it up with straps three inches by a half. Just how much he will have to pay for wrecking a good sized section of our second story wall and ruining a lot of fine lithographed work, where the chute shot through the wall, knocking two windows into one, has not yet been determined.

Marcus & Co. have a timid engineer, afraid of carrying water too low in his "kettle." Was once blown up by a crown sheet giving way in a locomotive boiler, and does not care to repeat the experience. So he has had one or two new try-cocks put in, raising the water-level about a foot; and has been trying to run his engine with hot water instead of steam... .....I notice that they are not running at Marcuses this morning, and my friends Weld and Kastner tell me that the new cylinder at Marcuses will not be ready until to-morrow two weeks. .. ..This afternoon's paper contains this "want" advertisement, under "Situations Wanted—Males":

ENGINEER wishes situation, low pressure job. Address CAUTIOUS, 77 Star, Uptown.

* * *

I never before knew that Wiswell could swear. But since this morning I have changed my mind. I have also greatly revised my opinion as to the possibilities of the English language in the line of picturesque, varied and burning invective. Seems his alleged engineer has been experimenting as to the crushing strength of white pine when used as a strut or brace. Having no testing machine he put his test-piece—say 28″ long x 4″ wide x 2″ thick—between the safety valve lever and one of the joists of the floor above the boiler room. (That floor happens to be that of Wiswell's private office, where he spends most of his time.) The leverage was against the valve and in favor of the wood, so the engineer couldn't crush it. Wiswell happened to go down into the boiler room, a thing he had seldom done previously—and about the first thing he saw was this piece of two-by-four. Wiswell is insured, but there is nothing hasty about him—in business matters—and he is in no hurry to realize on his investment in the Perennial Assurance and Benefit Association. The instant he saw that stick there was a deafening explosion. It wasn't the boiler, it was Wiswell. Talk about damming the Housatonic! Why, he could have permanently obstructed the Niagara and not half tried. The new man who runs that boiler will find blue mould

all over the boiler room walls, and all the brass fittings turned green, as the results of Wiswell's cursory remarks to that alleged—and late—engineer.

From the above incident there may be drawn two large cold-rolled morals.

One is that engineers should not try experiments in the crushing strength of woods used in construction, unless they are properly equipped.

The other is that the boss ought to go down into the boiler room oftener than once in a very great while.

* * *

The engineer at Shore's place has just put in a queer requisition—for a pair of rubber boots, to wear in his engine and boiler room. The "Smart Aleck" of an architect never bothered himself about the water level, and the result is that the recent high wind has caused the river to rise a few feet and soak into the low-lying districts, with the result of putting about a foot of water in Shore's engine and boiler room.

The engineer says that it saves him wetting down his ashes, and that he's a Baptist anyway, but he thinks that Shore ought to supply the rubber boots. Shore says that when he goes down to that architect's office it won't be rubber boots that he'll wear, but broad-gauge Waukenfast's.

* * *

The best place to have a boil (I like "bile" better; sounds hotter) is on the other fellow. And the best way to cure hot bearings is never to have them. In this respect, to paraphrase a noted saying, eternal lubricant is the price of coolness. This plan of getting within touch of seizing fast, and then sloshing in olive oil and sulphur or any other saving mixture, doesn't always work. It reminds me of Sandy MacGregor and his mare. He tried accustoming her to live on nothing, by a plan of gradually tapering off. It worked all right for a long time and nearly succeeded; but when he got her down to one straw a day, the poor thing died.

Some of these new kinds of automatic high speed engines are little swans in that they only sing just as they're dying. You hear a knock or a squeal, and before you can say Jack Robinson or even Rob Jackson, they're all tight and hot; and tight "for keeps" sometimes; for any self-respecting fly-wheel will brook no restraint from such a miserable little stumpy thing as a crank-pin. The fly-wheel feels in duty bound to go on around, crank-pin or no crank-pin. Now a connecting rod with part of a crank-pin in its fist can play hob if it gets even half a show.

Hence, I believe in feeding cold oil and not hot melted grease, on any bearings in which I have either a direct or an indirect interest.

* * *

Whenever I hear the exhaust of an engine barking with one long and one short bark, I have my opinion of the engineer and I pity the engine owner. Of course, an engine which is "running on one leg" is harder on crank-pin and brasses than the work justifies; but the extra wear and tear there is not the only thing calling for commiseration. A "mamma-daddy" exhaust usually means a "mamma-daddy" condition of affairs all the way through. It means the outboard bearing down on one side, or the whole weight of the fly-wheel pulling on the main belt, or the piston-rod fluted, or follower bolts loose in their nuts and likely to cause a surprise-party some day. The lop-sided exhaust is just a sign of a lop-sided management, and often helps in making the "Profit-and-Loss" account lop-sided on the wrong hand.

* * *

If I were to want to hire you, William Sagger, to bend a three-inch shaft an eighth of an inch each way, ninety times a minute, day in and day out, for a year, you would decline the job, and might suggest that I buy an elephant to do it for me. There you recognize the fact that it takes power to perform such work. Yet right over your head, O William Sagger, is a three-inch shaft much more than an eighth of an inch out of line; and as it makes ninety turns a minute, something may strike you as a curious coincidence; and an idea may enter your auburn-crowned head and save your employer some money. A word to the wise, William Sagger, Shovel Engineer, is sufficient.

Do you see that little ninety-pound fireman? Well, do you know that he spreads coal over that ten-feet long grate as evenly as syrup on a griddle-cake, and never gets tired; while his predecessor, who could have swallowed him whole with a few preliminaries, such as buttering his head and pinning back his ears—used to get rank tired and used up, doing the same work, or at least firing the same boiler for the same engine and manufactured output? It is true that the big fellow shovelled more coal per hour than the little one does; but it is true also that it was his own fault—and his employer's misfortune. The little man knows where to put his coal, and when and how to put it there. The big chap fired unintelligently, and much of the fuel that he shovelled in went out of the stack in the form and manner of smoke, soot and such like. I would sooner pay the little fellow four dollars a day than the big one two, as he saves at least a ton a day; and coal up this way costs money.

* * *

That man over at Johnston's "works for six o'clock." His aim in life is to do just as little as he can for his eighteen dollars a week. The result is that he will never get more than that as long as he lives—unless by some labor combination he is "raised" along with other incompetents. He has time to read the *Daily Blatherskite* during work hours and to attend meetings of the Kickers' Association, evenings; but if it was a matter of reading a paper or a book that would tell him about his business and help make him worth twenty dollars a week; or if he was asked to join a set of his fellow engineers who studied out the best ways of doing their work, once a week, of an evening, he would have no time; would be "driven clear up"; "would not have time to breathe as it was." The man whom Johnston had before him was soaking in ideas all day from some paper or book, and from his friends of an evening. Now he gets thirty dollars a week, and is really worth three times as much as his successor.

* * *

So Waters told you that if he caught you around his boiler room again talking to his fireman about the wrongs of labor, he would throw you out of the window into the canal? Well, I've known Waters a long time, and I'd advise you to keep out of that boiler room, or else to wear your oldest suit of clothes. Here's a fireman who when he came to Waters didn't know a shovel from a slice-bar, and wasn't worth four dollars a barrel, delivered, terms ninety days. Now he can fire fairly decently, and is getting twelve dollars a week. Soon, under the present conditions, he'll be able to start the engine without getting her stuck on the centre, and can be trusted to oil up. He is being made a mechanic instead of a laborer. He has got instruction which has already produced for him a difference in wages of $300 a year, which, capitalized, represents $6000, coin of the realm; and you are trying to make him dissatisfied.

I wonder Waters *warned* you!

* * *

Powers is "mad clear through." Says he wishes his knees were double-jointed so he could kick himself "with thoroughness and despatch." Saved three dollars on a sight-feed oil-cup, three months ago, and has just found his engine cut so badly that it will cost him about forty dollars to get it bored out and the chest and valve faced off. His engineer, Babbitt—a right good hard-headed fellow—told him when he bought that cup that he would be "saving at the spigot and wasting at the bung hole," but he didn't believe it. Now he knows it; and that isn't the worst of it; he knows that Babbitt knows that he knows it. I only hope that he won't rush off into the other extreme, and buy the most expensive article offered, just because it costs more than the Standard; because if he does I expect to hear of some pretty badly cut piston rods and valve rods. There's a patent packing fiend working this vicinity, that, should the said cutting occur, will also exert his persuasive eloquence on Powers and probably with success, judging from the sight-feed oil-cup episode; for such men as Powers generally need more than one lesson of the same sort, before they learn it thoroughly.

A NEW Speed Indicator for Railway Trains, based on the use of a tuning fork sounding the note of A natural, and making 435 vibrations per second, is stated in the *Avenir des Chemins de Fer*, to have been designed by M. Sabouret of the Orleans Railway, France. One of the prongs of this tuning fork is provided with a stylus in the well-known way and inscribes its vibrations on a sheet of paper coated with lamp-black and mounted on a cylinder. The latter is driven by clock-work. If, in such an apparatus, the fork and the cylinder carrying the diagram paper can be set in motion by a train, and can again be stopped after a certain known distance has been passed over, it is clear that all the data for determining the train speed are made available. In M. Sabouret's device the tuning fork and paper cylinder, together with the necessary clock-work, are fitted in a comparatively small case placed in the road bed. Four small pedals are arranged along the track, and are connected with the case by rubber tubes. One of the wheels of the locomotive, in passing over these pedals, compresses the air in the rubber tubes. This sets the operating mechanism in motion, and the registration of the vibrations of the tuning fork commences. After the locomotive has covered a distance of six meters, one of the wheels comes in contact with the last of the four pedals and the compression of the air in the corresponding tube stops the operation of the apparatus. It remains then simply to determine the number of vibrations recorded during the intervals. Dividing this number by the known number of vibrations which the fork makes in a second will give the time which has elapsed between the starting and the stopping of the mechanism, and, consequently, the speed of the engine. The error of the device is said to be about 2 per cent. at a train speed of about 60 miles per hour. Fixing the apparatus to the rails and road bed is stated to take only about 10 minutes, and the apparatus itself is said to be almost invisible, so that train speeds can be determined without attracting the attention of an engineer on a locomotive.

Purification of Water by Metallic Iron, is the subject of an interesting paper recently read before the Franklin Institute by Mr. Easton Devonshire. The method devised by Mr. William Anderson, Director General of Government Ordnance Factories in England, was described by Mr. Devonshire. Briefly, this method consists in the use of a revolving purifier, and instead of allowing the water to flow downwards through a motionless mass of the purifying material, the showering down of finely-divided particles of iron through a flowing stream of water is effected by suitable appliances. The action on the iron in the purifier is one of reduction, the carbonic acid brought by the impure water dissolving a minute portion of the metal and forming a protosalt of iron. On issuing from the cylinder into the open air, the protosalt is gradually converted, by the action of atmospheric oxygen, into the insoluble form of ferric oxide iron rust. The action of the ferric oxide in its nascent state in impure water is to burn up, as it were, the organic matter. There is, however, a further action of very great im-

portance, that of coagulation. In its formation the ferric oxide incases in its flakes the finely divided matters held in suspension by the water, in many cases in a condition of such minute subdivision that they cannot be removed by the most efficient of mechanical filters. These matters are collected together or coagulated, and form with the ferric oxide a flocculent precipitate of such a nature that it can readily be removed by rapid mechanical straining. The purification of the water is accomplished as soon as the whole of the protosalt of iron is converted into the insoluble form of ferric oxide, but to complete the process it is necessary, in the case of water intended for supplying a city, to strain out the precipitate. This is done by passing the water through filters composed of sand. Such filters may be as shallow in depth as will insure a homogeneous layer of sand.

The Preservation of Piles, whatever preservative may be employed, should, according to Mr. E. A. Walberg, the author of a recent essay upon the subject, be preceded by charring the surface so as to kill germs, open the pores of the wood for the antiseptic, and destroy the nutritive upon which the worm lives while beginning its action. The perfectly sound condition of the piles in the Charleston wharves after seven years of exposure proves the efficacy of this process, since untreated piles in those waters are eaten entirely through in less than two years. The Nicaragua Canal Construction Company also has given orders to char all the piles to be used in the Greytown harbor works.

A New System of Tunnelling consisting of a method of supporting the superincumbent earth roofs of tunnels, sewers, and subways during construction has been invented by Messrs. Jennings, Stannard & Co., of 94 Victoria Street, Westminster, and has been applied in practice on the Great Northern Railway in the construction of the company's new tunnel at King's Cross. The London *Times* in making the statement from which the above is abstracted expresses the opinion that the invention is of importance in the prevention of the subsidence of soil over the permanent brick-work structure, which sometimes happens when the space created by removal of ground for the usual system of timbering is not fully filled in with packing. It also effects a considerable economy in the cost of construction. The new method consists in placing a series of flat steel bars, or needles, as they are termed, side by side within the excavation, so as to form a complete temporary lining within which the permanent brick arch of the tunnel is built. The needles used in the King's Cross tunnel are 10 feet long, 6 inches wide and 2 inches thick, and they are linked together side by side by means of longitudinal tongues and grooves so that they can accommodate themselves to any transverse curve without separating from each other laterally, while at the same time they are capable of being moved forward individually. The needles are inserted and supported in the same way as ordinary tunnel bars, and after the brickwork has been built within them they are separately pushed forward by screw-jacks into the face of the work in front. The method has been satisfactorily used at King's Cross for several months past. At one point of the work the crown of the tunnel is within about six feet of the surface of the roadway. With the ordinary system of timbering the road would have had to be opened up, as the timbering would have reached to within a few inches of the surface. With the new system the traffic of a very busy thoroughfare remains uninterrupted, the needles being six feet below the road level. This points to the value of the invention in connection with underground work in towns and cities, as it prevents not only the interference with street traffic, but the disturbance of gas and water mains and telegraph wire or other existing subways.

The New Steel Bridge over the Columbia River will have a length of 6000 feet from the Washington to the Oregon shore. It will be erected upon pneumatic piers and double tracked, with a roadway on top for teams. The pivoted, or draw pier, will support a draw which will give an opening of 200 feet space on either side for vessels to pass, and the span immediately south

of the draw span will be 375 feet. The structure is to be 10 feet above high water and 40 feet above low water. On account of the sandy formation it will be necessary to go down 80 feet below low water to get a firm foundation. There it rests on a foundation of coarse gravel similar to that upon which the great bridges across the Missouri are built. This structure will cost over $1,000,000, and will be finished before January 1, 1892.

A Temporary Air-Compressing Plant of large proportions is now in use by Messrs. Rodgers & Clement, contractors on the Niagara Tunnel. It consists of three "class B" Rand 18" x 30" duplex compressors, compressing to a gauge-pressure of 100 lbs. into two large condensers, whence the air is led by an 8" distributing pipe to shaft No. 2, and thence through 6¼ inch pipe to shaft No. 1. At the latter a third reduction of the pipe to 4" is made, this pipe extending 2400 feet to shaft 0. The total distance of transmission is 6000 feet, and the pressure at shaft 0, is reduced by friction to about 85 lbs. per square inch. An aggregate of 630 h. p. is required for driving these compressors.

The Great Bombay Dam, says the *Pall Mall Gazette* (London), now being built in connection with the water system of Bombay, will impound the water of a valley draining into the sea south of Bombay. The wall will be 2 miles long, 118 feet high, 93 feet wide at the base and 24 feet wide on top. The reservoir so formed will have a surface area of 8 square miles. The work is being done by 12,000 Hindus. The cost of the masonry is estimated at $2,500,000.

The Coming Propeller for Steam Vessels will be, in the opinion of the English engineer, Mr. J. Ruthven, that known as the water-jet propeller. He believes screw propulsion has been carried to the last limit of its possibilities, and that the direct projection to the rearward of water first pumped inboard and then forced outboard to the rear will ultimately solve the problem of economizing the great waste of power known to inhere in the action of the screw. Whatever the ultimate possibilities of the jet-system may be, recent experiments with it in New York Harbor indicate a long road to be travelled before it can show superiority to screw-propulsion.

The French Government Experiments with steel at low temperatures indicate that, with gun steel, the expansion per degree of temperature is not uniform. On the contrary it increases with the temperature. By lowering the temperature of the bars to —70° F. and —100° F. their elastic limit was raised 11%, the hardened steel having its breaking load increased 6%, while that of the unhardened was increased 3%. The experiments, however, showed that the brittleness of the metal was notably greater at the low temperatures than at normal temperatures. The hardened steel required an average of 12.7 blows to break it at the low temperature, whereas an average of 14.4 blows were required at normal temperature. The unhardened metal broke under an average of 5.9 blows at the low temperature as compared with 14.6 blows at normal temperature. It thus appears that, while the tensile strength of the metal is somewhat increased by cooling, its brittleness is increased and probably this will be found true of all metals. The cooling of the metal was found to have produced no physical change after its restoration to normal temperature. It is also noteworthy that the resistance to blows at normal temperature of the hardened and unhardened steel is almost exactly the same.

The Greatest Railroad Scheme yet projected, had its practical work begun on the 10th of April, in the departure of the Second and Third Corps of Engineers of the Inter-Continental Railway on the steamer *Newport* for South America for the purpose of making the preliminary surveys, and determining the feasibility of the enterprise. These corps are respectively under the command of Col. W. F. Shunk of Harrisburg, and J. Imbre Miller of Philadelphia, both of whom are of high repute in the engineering profession. The first corps, which is to operate in Mexico, has not yet started. The engineers now *en route* will rendezvous at Quito, whence they will separate in different directions to execute the survey, which is to cover a

route of no less than 6000 miles from Tehuantepec to Jujui, close to the southern extremity of Bolivia. The two corps comprise, besides their commanders, Messrs. Robert Burgess, C. H. O'Connell, James Parker, Jr., Mr. Dempsey, William D. Kelley, Winter S. Wilson, J. Douglas Forster, Dion U. Martenez, and Assistant Surgeons Osgood and Rush of the U. S. Navy. This great survey cannot fail to secure important results, whether the railroad project prove feasible or otherwise. The governments in interest are to defray the expenses of the survey. They are the United States, Mexico, Guatemala, Salvador, Costa Rica, Colombia, Ecuador, Peru, Bolivia, the Argentine Republic and Brazil. The resources of modern engineering are such as to lend confidence to the belief that this great project will be realized. The estimated time for completing the survey is fifteen months. In view, however, of the extent of the work and unforeseen contingencies, it will not be surprising if this estimate is somewhat too limited.

The Failure of the Fish Torpedo in the recent attempt to blow up the iron-clad *Blanco* in Chilian waters, was accompanied by some rather ludicrous eccentricities in its behavior on that occasion which is exciting adverse comment in naval and military engineering circles. The Washington correspondent of the New York *Sun* writes that "it was not comforting to the torpedo enthusiasts to learn that the torpedo in this case had missed its target and destroyed a dry dock worth probably $500,000, in which the insurgents, who were at sea and directed the torpedo at the foe, were probably more deeply interested than the Government forces, which are mostly on land. It was perceived that these weapons might, as had been feared by some officers, prove to be dangerous boomerangs, that would destroy the vessel that ejected them or another of their own squadron. Then, too, the officers who had leaned towards the belief that torpedo boats would prove to be a powerful means of defending our almost unprotected ports were surprised to learn of the ease with which a simple sloop of war knocked such a craft all to pieces at one broadside. The terribly destructive effect of one of the modern heavy ordnance shells was also noted with interest, as was also the fact that the forts managed to chase away the sloop of war with ease. Altogether the engagement has not been without profit to our naval officers, who are awaiting with interest an official report of the affair from some of our own ships at present in Chilian waters.

The Railway Cars of the Future must have their weight reduced while their strength is retained. This is the opinion of Mr. Chauncey Depew, as reported in the New York *Sun*. Of inventions in this line he is reported as saying: "The steel car is perhaps the most important of these, and I would not be in the least surprised to see steel passenger and sleeping cars run on our fast lines in America in a few years. Mr. Buchanan, the superintendent of motive power on the New York Central and Hudson River Railroad, has in mind a steel car which is shaped like a cigar. By building your car cigar-shaped and of steel you get the reduction in weight and the benefit in speed that is sure to follow a reduction of the resistance of the atmosphere. The idea I believe is to have the cars linked together after the manner of the present vestibule system. The circular form of the cars will not permit the wind to eddy about and between them, which, of course, is a check to speed. On what we call our limited trains, with the number of cars carried by them, the engines are taxed to their utmost capacity, We must decrease the size of trains as well as reduce the weight of cars. This branch of course necessitates an additional number of trains, yet the population is not large enough to justify taking such a step. Ten years from now things will be different." Perhaps the time named by Mr. Depew for effecting these changes is somewhat too short; but when we remember how many things in the engineering and mechanical world in popular use ten years ago have been since relegated to the category of ancient history, we are not disposed to dispute his opinion.

Effects of Oil Hardening and Annealing

have recently been made the subject of experiment by leading steel manufacturers in Sheffield, Eng. A 9-inch plate of steel was cut into two plates, each four feet square. One piece was left untreated and the other was oil-hardened and annealed. They were fired at by the 6-inch gun with Firth steel projectiles weighing 100 pounds. The striking energy of the blow upon the untreated plate was 2389 foot-tons, and the energy of the blow upon that which had been treated was 2378.5 foot-tons. It is reported that in the latter case the projectile made an indentation of 10½ inches, so that light was just visible through the centre of the bulge at the back of the plate. The projectile rebounded, broken into three pieces. The plate was cracked through, but was whole, and no material was splintered out either at its front or back. In the case of the untreated plate, the shot passed through, and the splintering of the steel around the hole in front of the plate spread over a space of 15 inches across. The splintering around the hole at the back of the plate covered a space of 31 inches across. The plate did not remain whole, but went into six pieces.

A New Air Ship was exhibited by Mr. W. F. Wallace, a Cincinnati Aeronaut, at the 2d Regiment Armory in Chicago while this magazine for April was on the press. The trial was said to be very successful. In shape and construction the aerial ship resembles Pennington's airship. A balloon containing 7000 feet of hydrogen gas sustained the apparatus in the air. A car of aluminum is attached. There is a paddle at the front, which is worked with a crank by the occupant of the car and this furnishes the propelling power. A rudder steers the machine. The air ship circled around the large hall carrying a lad weighing sixty pounds and an aeronaut's outfit. The windbag is 28 feet long and 14 feet in diameter. The material used weighs 87 pounds, and the inventor claims that his machine has a carrying capacity of 500 pounds. A pair of wings made of tin form an aeroplane, and, when they are extended, the ship descends without any apparent effort.

The Compounding of English Words in the writing of specifications for machinery, building, heating apparatus, patents, etc., is a matter not only of good grammatical usage, but it often involves legal points in patents and contracts. In telegraphy, also, the proper compounding of words is a matter of importance as affecting the cost of messages, especially so in trans-atlantic communication by cable. There is great diversity of usage in this matter, and hitherto there has been no reliable guide to uniformity. It is, therefore, with satisfaction that we call attention to a small but thorough-going treatise upon the subject from the pen of Mr. F. Horace Teall, of the staff of the New Century Dictionary, who has devoted five years to the study of English compound words, the grammatical, rhetorical and philosophical laws that should govern compounding, and the usage of the best writers of English with reference to compounds. Mr. Teall has brought to bear upon the treatment of this subject not only scholarly attainments and a rare critical talent, but also a great deal of research, as will at once be apparent upon inspection of his interesting and instructive work. It is entitled "The Compounding of English Words," and is published by Mr. John Ireland, 1197 Broadway, New York.

A New Rail-Joint has been patented by Mr. John C. Humlock, of Wyoming, Pa., and has been tried on the Delaware and Hudson Railroad, where it is reported to have proved a joint of great smoothness and elasticity. The connecting plates are not as heretofore, straight bars, with elongated holes for the bolts, but are twisted medially to form a spring which yields enough under the expansion of the rails to compensate for elongation. The part thus twisted is somewhat thinner than the rest of the bar, and the plate, which is rigidly bolted to the joined rails, has thus some vertical elasticity at the middle point. It is asserted that the apparent value of the invention has resulted in handsome offers for its purchase, but the inventor yet retains the entire interest.

An Interior Ship Canal of a capacity to float vessels of 100 tons burden is to be constructed in connection with the new

line of railway connecting Gualan in Guatemala with the city of Guatemala, the capital of the republic. The canal will connect Gualan with Point Lengua de Buey near Port Livingstone, on the Caribbean Sea, a distance of 52 miles.

The Nicaragua Canal, according to the *Globe Democrat* (St. Louis), was projected 340 years ago in the days of the Spanish occupation by the Spanish explorer Gomara, who pointed out the route as the most feasible for connecting the two seas. The Spanish Government did not at the time give the matter attention, but in 1781, desiring quicker communication between the oceans, sent out an officer named Gallisteo to make a survey of three different routes, and among them that through Nicaragua. He also reported in favor of the latter, but Spain could not raise the funds for construction. In 1838 the route was again surveyed, this time by the English engineer Bailley, employed by the government of Nicaragua, and again in 1851 by Col. Childs for a company which proposed to undertake the canal. In 1873 an officer of the United States Navy made the surveys, which resulted in the choice of the present route.

The Shipment of Locomotives to New South Wales, made the past month by the Baldwin Locomotive Works, is, on account of the number shipped, the reasons for giving the order to an American firm and the character of the locomotives, an event of scarcely less than national importance. Twenty-seven were shipped at once by the steamship *Henley*, twelve being light tramway engines and the balance of the order being heavy ten-wheel passenger engines, built with three pairs of driving-wheels, and four-wheel leading trucks, and having separate eight-wheel tenders. It was on account of the superiority of these locomotives in hauling heavy passenger trains up heavy gradients and in turning sharp curves, that the order was placed here by the government of New South Wales. These passenger locomotives weigh 125,000 lbs each, not including tenders. It is stated that another order will be shipped during the present month, comprising twenty consolidation freight locomotives. The passenger locomotives shipped have each the capacity to haul, as a regular load up a grade of 176 feet, a total weight of 269,000 lbs. besides the weight of the engine and the tender.

Liquid Fuel for Steamships was recently considered in a paper read before the Shipmasters' Society (London) by Captain W. V. Carmichael. To the reluctance of steamship owners to adopt liquid fuel in ocean steamers and partly to the cheapness of coal is attributed by Captain Carmichael the hitherto small use of such fuel for marine propulsion. Its use can in his opinion be made to effect a considerable economy of space as the oil can be stored in the cellular bottom of the vessel. Moreover, the fires can be entirely controlled by the engineer on watch. As the consumption of oil, compared with coal, is weight for weight, one-half—ten tons of coal, in other words, being only equal to five of oil—the storage of fuel can be made much more compact and easier of access and less time is required in fueling the ship. Port charges are also lessened, as more fuel can be carried in proportion than formerly. Petroleum is found in all parts of the world, and competition would probably bring the fuel within easy reach of the commercial world. With regard to the important question of fueling men-of-war at sea during a blockade, he thought the large tank steamers of to-day could always fuel a fleet, even in heavy weather.

A New Form of Boiler-Check has gone into use on a number of Southern railways and seems to be meeting with considerable favor. Two of these checks are screwed into a chamber attached to the top of the boiler and having an ample valve at the bottom whereby steam can be shut off from the chamber. This permits cleaning, regrinding or renewal of either or both checks while the boiler is making steam. The location of the checks above the water line prevents interference of scale with their proper seating. The position also is favorable to perfect drainage and there is no danger of their freezing. This construction seems to accord with sound mechanical judgment.

THE Skillful Attendance of Domestic Heating Boilers is a matter of solicitude, not only with architects, but with purchasers also. One of the questions always asked by architects when their attention is called to a steam or hot-water heating apparatus which is a new claimant for public patronage, is, "Will it require a great deal of attention?" a question always answered in the negative by the manufacturer or dealer in such apparatus. For the most part, and so far as the best types of domestic heating appliances are concerned, the question may be truthfully so answered; and even with inferior types excessive attendance is necessitated more for the purpose of maintaining a supply of fuel than for any other purpose. No one thinks at the present day of putting in dwellings anything but a gravity return system of steam heating; and in such systems, when well erected, the loss of water is extremely small, being limited to that which escapes in the form of steam from air-valves. If an automatic water-feeder forms part of the system (as it does in the best types) the little that escapes is silently and immediately replaced and thus the attendance required to insure an adequate supply of water is limited to a brief daily inspection for ascertaining whether the water-feeding appliances are in good working order. The three things essential in attendance upon a well-constructed and erected heating boiler are, that it shall be kept clean inside and out, that it shall have a good supply of fuel on a well-cleaned grate, and that its water be maintained at the proper level. The latter, as we have seen, generally being provided for by an automatic feeder, the care of a domestic heater resolves itself into cleaning it and supplying fuel. Twice a day in mild weather, or three times a day in severe weather, ought to suffice for cleaning the grate and supplying fuel; but unfortunately, in the struggle for cheapness, many boilers are made with fire-boxes of too limited capacity to permit this. Architects and purchasers should therefore see that boilers have large deep fire-boxes before choosing them. There is a vast difference in boilers in the accessibility of their heating surfaces for purposes of cleaning, and this point should be carefully scrutinized by intending purchasers. If the construction is such as tends to become foul speedily, and, when so fouled, is hard to clean; and if the fire-box is shallow, the chances are that the task of attending it will be burdensome. The durability of the fire will depend in large measure upon its depth. A fire-box for either a steam boiler or a hot water boiler ought not to be less than 8 inches in depth below the combustion chamber or gas space above the fire; and 12 inches is better still. Of course skill in the attendance of such boilers means scarcely more than habits of regularity and thoroughness. The supply of fuel should be made at stated times, and the cleaning of the grate should be done at that time also. It will be found, also, that a boiler of any given type, using a particular kind of fuel, will need to have its heating surface brushed off clean at stated periods depending upon its particular construction and the kind of fuel used. Servants, porters, and unskilled help can easily be taught to perform these duties, and hence with a proper selection of an apparatus and its skillful erection, there need be no hesitation on the score of attendance.

A State Association of Engineers and Architects was organized on the 4th April at Roanoke, Va., by a meeting at which were present about 100 prominent civil, mining, mechanical and electrical engineers representing all parts of the State, among whom were Messrs. T. J. Kimball, Philadelphia; C. R. Boyd, Wytheville; Jed. Hotchkiss, Staunton; J. I. Hernsberger, Shendun; W. J. Hurlbut, Buena Vista; E. C. Vincent, Staunton; S. Tompkins, Charlottesville; Ed. S. Hunter, Lynchburg; James D. Moffett, Radford; A. H. Miller, Bluefield; J. A. Hall, Washington; R. O. Marr, Lexington; L. Chandler, Salem; G. P. Murray, Max Meadows; J. W. Goodwin, Lynchburg; E. Dunn, Alexandria; D. J. Howell, Washington, D. C.; J. L. Brenizer and A. V. Crawford, Graham; Edmund Grover, New Castle; W. W. Blackford, Lynn Haven; George L. Colgate, Bedford City; W. H. Burch, Wytheville; N. S. Lutz, Lynchburg; Adron W. Morris, Bristol; H. P. Beck, Bluefield; M. J. Calfee, Elliston; C. M. Brockton, Newport News; W. W. Tortion, Charlottesville; S. B. Mosby, Bradford; T. Draper, Norfolk; John Johnston, Rocky Mount; W. L. Marshall, Bluefield; W. O. Whitescarver, Basic City; F. T. English, Shenandoah; W. S. Green, Columbus, Ga.; Garrett Savage, Oak Level; E. Harrison, W. G. Fooloog, and C. B. Smith, Rocky Mount; Percy Ash, Buchanan; Ward Crosby, Cambria, and Frank Conrad, Winchester.

The following permanent officers were elected: President, J. H. Wingate, Roanoke; first vice-president, W. E. Anderson, Blacksburg Mechanical and Agricultural College; second vice-president, C. R. Boyd, Wytheville; secretary, H. W. Newby, engineer of construction of the Roanoke and Southern Railroad; treasurer, James R. Shick, assistant chief engineer Norfolk and Western Railroad. A constitution and by-laws were adopted, and Roanoke made head-quarters of the organization. Summer and winter meetings will be held.

Designs for the Woman's World's Fair Building have been prepared and submitted by fourteen women, and of these all but three have been rejected. These three are said to be extremely good. The competition seems to have yielded as good results as is usual in such competitions by men, and demonstrates that, so far as the design of structures is part of an architect's work, there is a place for female talent in this as in other professions. The successful architects are Miss Sophia G. Hayden of Boston, who was awarded the first prize—$1000; Miss Lois L. Howe, also of Boston, second prize—$500; and Miss Laura Hayes of Chicago, third prize—$250. It is understood that Miss Hayden will at once proceed to elaborate her plans. Her design is in the style of Italian Renaissance with colonnades broken by centre and end pavilions. The ground plan of the building is 200'x300' and the height of the structure is to be 50 feet to the cornice. The cost is limited to $200,000.

A Large Catholic Seminary at South Yonkers, N. Y., will have its corner-stone laid with imposing ceremonies, and in accordance with the ritual of the Roman Catholic Church, on the 17th of May. It will be an imposing structure not only from its design, prepared by the well-known architects, Messrs. William Shickel & Co., of New York, but also from its size and the well-chosen site which overlooks the Hudson River from a grand height of 329 feet from tide-water. The building is to have a frontage of 354 feet, with wings at the ends projecting 85 feet forward and inclosing on three sides a plazza, with a southeastern outlook. The building will have a depth of about 200 feet and a chapel extending to an additional depth of 120 feet. There will be a basement and four stories. It will have a pitch-roof, relieved by dormer windows and a dome. There will be accommodation for the residence of 150 students in large, well-ventilated rooms, and for 12 professors, besides a room for the large library to be brought from the St. Joseph's Provincial Seminary of Troy, N. Y., of which the new institution is to be the successor. In addition there are to be ample study halls, a refectory, kitchen, laundry, etc. The name of the institution is to be the same as that of the institution at Troy above

given. The cost of the building is to be $500,000.

The Ownership of Drawings is a topic of interest to architects discussed by a correspondent of *Architecture and Building* in a recent issue. He quotes from the schedule of fees of the American Institute of Architects the rule that "drawings as '*instruments of service*' are the property of the architect, and in support of its validity quotes the case of Hunt *vs.* Parmalee, decided some thirty years ago in a New York court, in which the court held that 'drawings are instruments with which an architect builds.'" He adds that as "architects are employed to build houses and not to simply make drawings, and as you would not think of carrying off a carpenter's kit of tools because you employ him to do a job of work; so, too, you should not think of keeping an architect's utensils that he has provided to build his house with. If this seems queer to any, they must try to get used to it, because it is sound doctrine. It is satisfactory to note that since the promulgation of the 'return' theory, it has become almost universal practice in the whole country."

The Growing Scarcity of the Finer Woods used for interior finish and in the manufacture of furniture, has advanced the prices of such woods materially within a short period. Especially is this the case with the finer grades of oak, that on account of their intrinsic beauty which increases with age, and the durability of the wood, are in constantly increasing favor with architects and furniture manufacturers. It is doubtful that any wood can be obtained in which finer effects of tone in color and mottle can be produced than in the best specimens of quartered oak, now brought from West Virginia, Tennessee and Arkansas. Specimens of furniture of this fine material now on exhibition in the first-class furniture stores of New York, are works of art that well repay inspection.

Beautiful Samples of Onyx from the Big Berg in Arizona, recently sent to Austin, Texas, were of such extreme fineness of texture that an immediate proposition was made to use this elegant material in finishing the new State capitol building. A prominent place for this stone in the United States market in view of the existing high tariff on Mexican onyx, and the intrinsic beauty of the Arizona onyx, is predicted.

The New Music Hall at the corner of Seventh Avenue and Fifty-Seventh Street, New York City, will it is now stated be fully opened by a musical festival to begin May 5, and continue till May 9. This institution, founded by Andrew Carnegie, when completed, will be one of the finest buildings for its purpose yet erected in this country. The promise of its fitness and its future usefulness was partly fulfilled upon the occasion of a recent rehearsal of the New York Oratorio Society (Mr. Walter Damrosch directing), in Recital Hall, one of the smaller halls to be used for recitals, etc. The difficult solution of acoustic problems in architecture, in so far as this particular room is concerned, has been most perfectly accomplished. The acoustic qualities of the hall were admired by all present, and were well tested by the performance of the orchestra and a chorus of 500 of the Oratorio Society. They were also closely observed by Mr. Damrosch and other competent critics present, all of whom concurred in the opinion that, in respect of its acoustic qualities, the hall is perfect. The main hall has not been publicly tried yet, but it is hoped that the festival in May will prove it to be equally good. This hall will seat 3000 persons.

Magnesia in Portland Cement, is the subject of a paper by R. Dyckherhoff in the *Chem. Zeit.* He calls attention to the dangerous character of cements rich in magnesia, their tendency being to expand slowly after setting, careful measurements of their expansion giving also only doubtful indications unless at least half a year has elapsed since gauging, and says he is disposed to fix the maximum permissible amount of magnesia in Portland cement at 4 per cent. The Association of German Cement Manufacturers has formed a committee to report on the subject; such makers as are using dolomitic material being specially interested.

South American Antiquities forming a very interesting collection are reported to have been secured for exhibition at the Columbian Exposition by Lieut. H. R. Lemley, U. S. A., the Special Commissioner to the Republic of Colombia in the interest of the Exposition. The collection includes antiquities gathered together through a period of forty years by a famous Colombian collector. It comprises articles in metal, particularly of gold, curiously wrought into figures of butterflies, lizards, toads, snails, fishes, etc. A writer in the *Correo Nacional* (Bogota) speaking of this collection says of it, however, that "most of the articles are in the form of massive gold idols, with insignias or allegories, such as sceptres of gold, representing on their handles crowned eagles and other birds also wearing crowns; utensils of gold for domestic use and musical instruments, some in the form of a cornet, whose notes can be heard a long distance. Attention is specially directed to a gold sceptre whose handle represents a very finely-worked group, showing a very artistic idea. Upon the wrist, so to speak, of the staff rests two large apes, one of which has upon its shoulders a small monkey; an eagle, very delicately modeled, clasps between its claws this monkey, and the two apes enlace with the extremities of their tails the feet of the eagle. Another very striking object is a massive gold idol, to which my attention was called on account of its strange shape, having a quaint crown set over an irregular face, two wings, a breast-plate in relief, massive legs, above them a cask, and in each hand a wand. I was not aware that the Indians had idols winged like angels."

Proposed Building Laws of far-reaching importance to architects, builders, owners and fire insurance companies, as involving the interests of them all, were recommended to be adopted at a recent meeting in New York of representatives of the American Institute of Architects, the National Association of Builders, the National Association of Building Inspectors, the National Board of Underwriters and the National Association of Fire Engineers.

The substance of the laws proposed is as follows:

That all buildings over 70 ft. in height be constructed throughout of incombustible materials, protected in the most approved manner for resisting fire.

That interior structural iron work in all buildings be covered and protected by fireproof material.

That all buildings over 50 ft. in height be furnished with permanent stand-pipes and ladders for the assistance of the fire department.

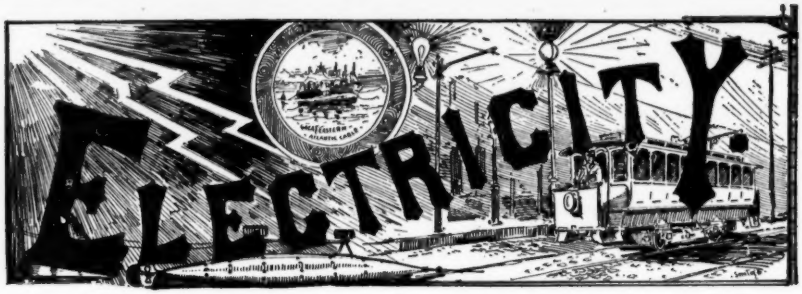
That the height of buildings to be erected should not be more than 2½ times the width of the principal street on which they are located, and that no building or portion of a building, except church spires should be more than 125 feet high in any case, except under special permit.

That the open floor-space not divided by walls of brick or other incombustible material, in all buildings hereafter erected for mercantile or manufacturing purposes, should not exceed 6000 square feet, without special permission based upon unusual and satisfactory precautions.

That every building which shall be three stories high or more—except dwelling houses for one family—and which shall cover an area of more than 2500 square feet, should be provided with incombustible staircases, inclosed in brick walls at the rate of one such staircase for every 2500 feet in area of ground covered.

That wooden buildings erected within eighteen inches of the boundary line of the adjoining property should have the wall next to the adjoining property of brick; or, when built within three feet of each other, shall have the walls next to each other of brick.

In the Erection of the new Equitable Building, in Berlin, the authorities refused to allow hoisting-machinery to be used. Every brick in the the superstructure was carried up on the backs of women. In America, if women were put to such work, the thunder of public indignation aroused by the sight, would almost shake down the structure. Is Germany, famed for her learning still so materially, so far behind us in civilization?



THE London-Paris Telephone Line was opened for public service on the second of April. The line has been built by and is the joint property of the British and French Governments. The total length of the line is 297 miles, of which nearly 270 are overhead, the submarine cable across the Channel being 24 miles long and there is an underground cable about 4 miles long at the Paris end. The transmission is said to be excellent and the line is absolutely free from induction. Considerable difference is observed between the reception at the two ends of the line, the volume of sound received in London being much greater than that heard at Paris. This is probably due partly to the fact that the submarine cable is not in the middle of the line and partly to the retarding effect of the length of underground cable at the Paris end. Residents of Paris who have long been accustomed to use the line between Paris and Brussels state that they can hear London much better than they can Brussels, which is good testimony as to the excellent electrical conditions of the new line. The charge for conversation between London and Paris is eight shillings ($2) for three minutes, no customer being allowed more than two consecutive turns if others are waiting to use the line. At present there are two pay-stations established in London and a third will shortly be opened. Private lines for direct communication from offices or residences will be rented. Numerous applications have been made for these lines and it is said that the financial success of the service is already assured. A curious difficulty has come up in connection with the use of the line for ordinary business purposes. London merchants who are accustomed to write and telegraph in French, find that when they attempt to speak and listen to French over the telephone it is a different matter altogether. No doubt, however, this difficulty will wear away with practice.

The Annual Report of the Bell Telephone Company, just made public, contains some interesting figures which illustrate the marvelous growth of the telephone industry in this country. The net earnings for the year were $2,869,418, giving a dividend of 22.95 per cent. on the capital stock of $12,500,000. On December 31, 1890, there were 744 exchanges, an increase for the year of seventeen. The total mileage of wire was 240,412, an increase of 47,199 over 1889. The mileage of underground wire had almost doubled being 54,690 as against 27,573 at the end of 1889. The greater part of this increase can be credited to New York City alone. The total number of instruments in hands of licensees in December, 1890, was 483,790, an increase of 38,929 over 1889. The estimated number of exchange connections daily in the United States is 1,438,294, or a total per year of over four hundred and fifty millions. Twenty-one towns and cities now have underground wires, as against thirteen a year ago.

The Electrical Utilization of Water Power has attained a far greater development than most people would imagine. A paper read by Mr. Madison Buell, at a recent meeting of the Buffalo Electrical Society, reviews what has been done in the electrical utilization of the vast amount of power so freely provided by nature in many parts of the world, and points out some of the important schemes of this nature about to be carried out. In

Switzerland there are nearly 200 electrical plants driven by water-power, the electrical energy thus obtained being used to furnish power to mills, factories and electric railways, and also electric light to hotels and other buildings; some of these plants have dynamos aggregating upwards of 1000 horse-power. In Austria and Italy similar installations exist and in Ireland an electric railway eight miles long is run by water-power. In South Africa water-power furnishes electrical energy for lighting and working the gold mines; in one of these installations the current is carried four miles from the water-fall to the mines, about 200 horse power being obtained at the motors. In Nevada and California the power obtained from water-falls is utilized by means of electrical machinery on a very large scale. At Aspen and Greenwood Springs there are large plants which furnish electricity for arc and incandescent lighting, and for running mills, pumps, hoists and tramways, many of the motors being miles away from the power-station. At Veazie, Me., there is a plant in course of construction which will be the largest of its kind in the world. The dynamos will have a capacity of about 2200 horse-power. Electric light and power will be furnished to the cities of Bangor and Brewer. Great preparations are being made to utilize the power of Lake Superior at Sault Ste. Marie; the water-power here is estimated at 230,000 h. p. At Spokane Falls, the power station at present supplies electrical energy for 12,000 incandescent lights and 2000 arcs, besides motors of all sizes and in great number. To replace the power by steam would mean an outlay of $10,000 a day for fuel alone. The plans adopted for the utilization of the power of Niagara Falls are calculated to develop 120,000 horse-power. The Pelton Water Wheel Company, of San Francisco, have sent to the Niagara Falls Commission an estimate of the wheels and appurtenances for one block of twenty thousand horse power.

Transformer Distribution has been discussed by Mr. James Swinburne in an extensive paper read before the London Institution of Electrical Engineers. Mr. Swinburne considers that the present method of distributing current from central stations on the alternating current system is open to objections. He proposes to do away with high-tension dynamos delivering current at high pressure directly into the mains, and would substitute machines generating current at a lower tension and station transformers by which the tension of the current would be raised before entering the mains. In this way the high tension current would be confined entirely to the outside mains between the station transformer, which raises the tension of the current, and the consumer's transformer, which lowers it again. Greater safety would be obtained in the station with the absence of high tension currents, and an additional advantage would be that the district immediately surrounding the station could be supplied direct from the dynamo without the intervention of any transformer at all, giving greater economy in distribution. Mr. Swinburne also advocates the use of single large transformers for local districts instead of supplying a separate transformer for each house. The single transformer would be connected to low tension mains which would supply all consumers in the district direct.

The Electrical Exhibition at Frankfort, to be held this year, will show the world a remarkable experiment in the electrical transmission of power over long distances. It is proposed to transmit 300 h. p. of the water-power of the river Neckar, at Lauffen, to Frankfort, a distance of nearly 115 miles, by means of a copper wire only 4 mm. in diameter. Numerous experiments have been made at the Oerlikon works, near Zurich, and, it is declared, with such successful results that no doubt is entertained as to the feasibility of the scheme. At Lauffen an alternating current dynamo giving a current of 4000 amperes at 50 volts pressure will be installed. This current will pass through a "step-up" transformer which will raise the pressure to 30,000 volts for transmission over the line. At the Frankfort end the pressure will be reduced by means of another transformer, and the current thereby

brought into condition for running motors at the exhibition. The line will be overhead throughout, the wires being supported on oil insulators of very high insulating qualities. The transformers are all immersed in oil in order to prevent the enormously high tension current from sparking across from coil to coil. The outcome of this scheme will be watched with great interest, as hitherto no practical experience has been had in working with such high pressure, 10,000 volts being the highest employed in practice today.

A Useful Improvement in Telephone Apparatus has just been patented by Mr. J. J. Carty, of the Metropolitan Telephone Company. This consists of a new form of magneto bell which permits the working of a large number of stations on a single line without in any way affecting the transmitting or signalling qualities of the line. It has hitherto been the custom in telephone construction to follow telegraph practice and loop in additional stations, thus greatly increasing the resistance and retardation of the line with every station added. In this way the limit was soon reached and it was found impossible to talk over a line with more than half a dozen instruments on circuit. Mr. Carty has constructed a bell which is designed to be bridged across the circuit, the two sides of the circuit being connected through the bell in the same way as in electric lighting on the incandescent system. The system is one of extreme simplicity and permits of the placing of an almost unlimited number of stations on a single line without the aid of any switching or other auxiliary apparatus; the signalling and transmission on lines of considerable length and having as many as twenty instruments connected are found to be as clear and distinct as though only two instruments are used. Besides increasing the efficiency of the line a great saving in construction is effected when the points to be connected are much removed from a straight line, only half the amount of wire being required in the branch circuits compared to that used by the old method.

The Tendency in Designing Street-car Motors is to reduce the gearing between the armature shaft of the motor and the car axle as much as possible, or better still, to do away with gearing altogether. In the electric locomotives on the London underground railway, the armature shaft forms the axle of the locomotive, and this is the first instance of direct-driven electric cars being put in practical operation. The conditions are favorable as high speed is required, and the track is so perfect that jarring of the motors is reduced to a minimum. The Short Electric Railway Co., of Cleveland, Ohio, has just produced a street-car motor in which the armature is mounted directly on the axle. The armature shaft is made hollow and the axle runs through it. To the end of the hollow armature shaft are keyed heavy crank discs of iron, and these are connected to the car axle by means of heavy coil springs capable of pulling, with very slight elongation, 2500 or 3000 pounds. This arrangement avoids shocks in starting as the power of the motor is gradually transmitted to the axle by means of the springs. The motor frame is supported on spring cushions, and the motor is entirely covered in by a sheet-iron casing, which affords protection from dust and moisture. The speed of the motor ranges between 100 and 150 revolutions per minute; there is no noise and wear and tear are reduced to a minimum.

Another Gearless Railway Motor has just been perfected by the Westinghouse Electric Co., who only a short time ago were in the field with a single reduction gear motor. The new motor which has been named the "Ironclad," as it is encased in iron castings of special design, has its armature built up directly on the car axle. Sheet-iron discs are keyed to the axle and the wire is wound over these to form the armature, which is only sixteen inches in diameter. The motor is practically hermetically sealed in the iron casing which is made in two symmetrical parts, sleeved to the axle, hinged on top and bolted together below. The car-wheels are cushioned in a special manner to reduce the jarring of the motor, and they are secured to the axle by a novel

device which permits of their being removed and replaced easily and quickly and without the use of special tools. Two of these gearless motors have recently been built at the Westinghouse Works at Pittsburgh, and the tests made have given results even more favorable than had been expected.

Underground Electric Railroads will probably soon be in operation in many large cities, and it is to be hoped that New York and Boston will promptly follow the example set by London in adopting this ideal method of dealing with rapid transit difficulties. In London another underground road to be operated by electricity is about to be constructed, the plans having been approved by the parliamentary committee. This road will connect the West End directly with the City, running from Shepherd's Bush to the Mansion House, a distance of about six miles. As this route is the diameter of the circle described by the present steam underground railways, the new road will be an immense boon. A power station of a capacity of 5000 h. p. will be built at the suburban end of the line. The trains will consist of six cars seating in all about 340 persons, and weighing with the electric locomotive 120 tons. The average speed is to be 14 miles an hour including all stops, the maximum speed to be 25 miles an hour. The present electric railway in London is such a success in every way, that it is said the public is agitating the question of compelling all the underground roads to adopt electricity as a motive power. The contrast between the old and the new is so great that they do not think they can endure the old very much longer.

The Elements of Dynamic Electricity and Magnetism," a new work by Philip Atkinson, A. M., Ph. D., is a book that can confidently be recommended to all who are in any way interested in the study of electricity. The book is elementary, as indicated by the title, but it appeals not only to the student of electricity or the working electrical engineer, but also to that great and growing section of the general public that finds itself every day brought into contact with the applications of electricity in some form or other. Every engineer and every investor needs nowadays to know something about electricity, and this is just the kind of book in which he will find its most important properties and phenomena explained in a clear and intelligible manner. The ground is thoroughly well covered and each subject is treated as fully as the limits of a work of this kind will permit. Batteries are described in three chapters after which follow two on magnetism and electromagnetism. In the chapter on electrical measurements a clear description is given of the various electrical units and their derivations, supplemented by a condensed treatise on the measurement of electric currents. The dynamo and motor electrolysis and electric storage are next treated, and to these chapters follow the two most interesting in the book entitled "The Relations of Electricity to Heat" and "The Relations of Electricity to Light." The relation between electricity and light is a subject of engrossing interest among electricians to-day, and Mr. Atkinson in a single chapter admirably summarizes the work of numerous investigators. A chapter on the Telegraph and one on the Telephone conclude this very useful and interesting book.

Long Distance Telephony is now all the fashion in Europe, since the successful inauguration of the London-Paris line. The Spanish Government is inviting tenders for the establishment of a complete system of long distance lines between the important cities of the Peninsula and the capital. The most distant capitals of provinces are not more than about 300 miles from Madrid, so that the establishment of telephone communication offers no particular difficulties, except those of construction in the mountainous regions. It is now proposed to construct a telephone line between Berlin and Vienna, and the project of connecting Brussels with London by telephone is also being mooted. Four Belgian towns are interested in this scheme, namely, Antwerp, Ghent, Verviers and Brussels, as all of these have important business relations with commercial centres in England. For the new line it is proposed to lay a

special submarine cable from Dover to Ostend.

An Electric Street Railway Freight Service has been established on the road between Seattle and its suburb, Ballard. It was thought that as the road runs out to a suburban town the addition of a freight car to the regular equipment of passenger cars, to be hauled by one of them, would be a possible source of revenue. This expectation has been fulfilled, and the freight service met with prompt appreciation. The freight business grew so rapidly that it soon overtaxed the capacity of the experimental car, and a special freight car was built. This car is built on the model of an ordinary railroad freight car, is 24 feet long, and is mounted on a Tripp truck, with two Thomson-Houston 20 h. p. motors. The car makes three round trips each day, and carries daily from 12 to 15 tons of freight. Such freight is carried as can be unloaded quickly at any point on the line as called for, and the charges for this class of freight will average from 12 to 15 cents per hundred weight. The company finds that the service pays over and above salaries of driver and conductor (who acts as express agent) better than any one passenger car, and the facilities provided are greatly appreciated by the residents along the route served by the road. An express office is to be opened at each end of the road. An electric road specially designed to handle freight is soon to be established at Fall River, but the operation of an "electric express service" after the fashion of that found so successful at Seattle, might be undertaken by many of the electric railways throughout the country.

For Electric Lighting on the Alternate Current transformer system it is argued by Mr. Swinburne, of London, that it is better practice to use alternating current dynamos developing current at 1000 volts pressure than to use machines designed to give 2000 volts. The reduction effected in the size of the conductors of the distributing mains by adopting the higher pressure is comparatively small, whereas the insulation must necessarily be heavier and consequently more expensive. Besides this for a pressure of 2000 volts both dynamos and transformers cost more than if designed for a working pressure of 1000 volts. Of course if the area to be lighted is very scattered the question of conductors cuts an important figure, but in compact districts the lower pressure will be found more advantageous, especially as so many people are possessed with a horror of high-tension currents. In this country it is the general rule to work at a pressure of 1000 volts on the alternating current system, in England it is common practice to work at a pressure of 2000 volts.

The Question of Municipal Ownership of Electric Lighting Plants has been much discussed in this country during the past year or so. Boston is just at present the centre of this municipal ownership question, as the question "Shall municipalities control gas and electric plants?" is now before the Legislature and promises to be an issue of the fall campaign. The committee on manufactures has reported on this question "No legislation necessary." It is argued that in the past competition has generally resulted in a pool or corporation being formed, but this argument can only hold good in very few cases. Legitimate competition generally exists where there is any field for it, and the consumers gain accordingly. It is common belief that industries municipally controlled can be conducted at much less expense than when private corporations have the management, but like many another popular belief this is entirely erroneous. As a general rule in reporting the accounts of a municipal plant many items of expense are entirely neglected and others are charged off to other departments. Hence the apparent economy, but the taxpayer has to pay the piper all the same.

A Chat With Europe by Telephone was the alluring title of an article in the initial number of ENGINEERING. In that article it was pointed out that for the present such a chat is scarcely practicable, but apparently there are people who believe that it is and will soon be a matter of every-day occurrence. From Philadelphia it is reported that "a distinguished authority on

the telephone says that telephonic communication between that city and Liverpool may be established in a few years. Experiments have already been tried on the Mackay-Bennett cable with telephonic connections, and although somewhat of a failure they were sufficiently encouraging to justify further investigations which are soon to be made. These experiments will be very expensive and may require some time in developing, but there is no doubt that both the capital and the brains to push them through will be found. A movement in this direction is already afoot, and the future of the promoters' plans will be watched with intense interest by the scientific world." Just so, but probably the scientific world knows more about the matter than the enterprising reporter who compiled this interesting story. Those who think that ocean telephony is practicable in the present state of the art had better read the article in the April number of ENGINEERING referred to; there they will find very clearly set forth the difficulties which stand in the way of such a scheme.

The Telephone Exchange at Albany was burned out early last month through an overhead wire coming in contact with the trolley wire of the Albany Electric Railway. This is the second occurrence of the kind at Albany during the last few months and the telephone service of that city has within the same period been twice disorganized by severe storms. The danger of fire occurring in the switchboards or other central station apparatus is a constant risk by which telephone exchanges are menaced when an electric railway operated by the trolley system is established in the immediate neighborhood. Various more or less serious fires have occurred in telephone exchanges owing to wires having become crossed with the trolley wire, the latest fire at Albany having caused damage to the extent of about $10,000. The trolley wire of the Albany road is not provided with a guard wire to prevent other lines from coming in contact with the trolley wire, but a guard wire, although it is certainly some sort of protection, is not always efficient as it is very often as much "alive" as the trolley wire itself, instances having been cited of the car being run with the trolley bearing on the guard instead of the trolley. The debated question of the supremacy of the single trolley system will have to be settled before very long, and it is fairly evident that the system is ill adapted for surface electric traction in cities. The day of the underground conduit is not yet come, and the storage battery car—the ideal system of electric traction for cities—has apparently been litigated out of existence for the present; but for city transit we must look to one or the other, certainly not to the overhead trolley wire.

At the Inventor's Congress recently held at Washington to celebrate the centennial of the institution of the American Patent system electrical inventions were particularly well represented. Many prominent electrical inventors were present at the congress. In the course of his address on "Epoch-Making Inventions of America," Judge Robert S. Taylor, of Fort Wayne, Ind., said: "Since Franklin drew the first submissive spark from heaven, Americans have been foremost in the great field of electricity. The subjugation of this great force was begun when Professor Morse taught it to talk. The steam engine is the breath and muscles, the telegraph the nervous system of the body politic." Prof. Cyrus Brackett of Princeton read a paper on "The Effect of Invention on the Progress of Electrical Science," and Prof. Thomas Gray of the Rose Polytechnic Institute, Terre Haute, Ind., delivered an eloquent and most interesting address on "The Inventors of the Telegraph and Telephone." This paper is one that every one interested in electrical science should read and every electrician should study and preserve it.

A bath for Electroplating with Palladium is "Water, 2 liters; chloride of palladium, 10 grammes; phosphate of ammonia, 100 grammes; phosphate of soda, 500 grammes; benzoic acid, 5 grammes. This bath is suitable for all metals except zinc, the latter being excepted for reasons obvious to chemists.

MINING LITERATURE has grown to proportions such that according to Prof. C. Le Neve Foster it is "impossible save for those who have an exceptional amount of leisure, to thoroughly digest the pages of new matter that are laid before them. A want and a serious want of the mining profession is a publication of the nature of a *Review of Reviews*, which would give in small compass the pith of the useful papers which are now scattered through our provincial and foreign periodicals, and the transactions of various mining societies. Even if such a book appeared but once a year, as a year book of mining, the editor would earn the thanks of a host of over-worked mining men, who now have to wade through page after page of books in order to ascertain whether or no there is anything that concerns their particular branch of the profession. A mere list of titles of papers, with proper references to the original volumes, would be better than nothing." In this opinion is found a sanction for the publication of this magazine. This *flood* as Prof. Le Neve Foster aptly styles it, is not confined to mining, but it is swelling the fountains of technical literature in all departments. The ENGINEERING magazine, therefore, while it measurably supplies the want of a *Review of Reviews*, will in its list of articles under the heading OUR EXCHANGE TABLE, exactly meet the principal requirement. It will supply an accurate guide to the selection of technical publications, so that such only may be sought as contain articles adapted to special needs in different departments of engineering; and in its edited departments will furnish, in condensed form, such a summary of monthly progress as will keep professional men abreast of the times without an exorbitant demand upon their time. These features should commend this periodical to busy men engaged in any department of engineering, or any of its collateral or dependent departments of industry.

Inferiority of Safety Lamps used in American Mines, as compared with those employed in England is asserted in an editorial leader of the *Colliery Engineer* for March. There has been much improvement abroad in safety-lamps during recent years. The article named charges that while we "Americans pride ourselves on our progress and aptness to utilize all improvements, we have been the slowest nation in the adoption of safety-lamps that more fully meet the requirements in our generally well ventilated mines. The Royal Commission on Accidents in mines (British) was in existence for seven years, and its reports are marvels of thoroughness and completeness. Exhaustive tests were made with all known types of lamps that possessed the slightest claim to merit." From the report of this commission the following requisites are quoted: "To be really efficient a safety-lamp should satisfy the two following conditions: (1) The source of light within the lamp should be unable, under any circumstances at all likely to occur in working coal, to cause the ignition of an inflammable mixture of fire-damp and air, even when this is passing at a high velocity. (2) The lamp should yield during an ordinary working day a sufficiently bright and steady light even when exposed to a strong current of air." But these conditions may be satisfied in a lamp so long as it is in perfect order while it may, by faulty construction, be liable to fail when used only with such care as is ordinarily

practicable to secure for such appliances. In order that such failures should be prevented, the report goes on to say that a safety lamp should be of simple construction, and admit of thorough and easy inspection. Lamps which met with special commendation in the report as meeting these requirements most nearly, are the Gray, the Marsaut, Evan Thomas No. 7, and the Bonneted Mueseler.

A Substitute for Spongy Platinum so far as regards its affinity for hydrogen gas, as exemplified in the well-known Dobereiner's lamp, is stated on scientific authority to be asbestos saturated with platinum oxalate, and then ignited in a platinum crucible. Asbestos, so treated, is said to become incandescent in air at 80° F which also contains 0.5% of coal gas. If the platinized asbestos be itself warmed to 80° F, in a colder atmosphere the same effect is produced if coal gas be present. If this statement be verified in practice this is certainly a very delicate test for the presence of escaping coal gas, from mains and service pipes.

The Great Delamar Mine in Owyhee Co., Idaho, is reported to have been purchased by a company of English capitalists from Mr. J. L. Delamar, for $475,000 cash and 25,000 shares of the company worth, at present quotations, about $1,300,000. It is reported that Mr. Delamar, who is World's Fair Commissioner for Idaho, will spend $50,000 of his own money to make the exhibition of that State a creditable one. It would seem that he can afford this liberality without fear of immediate financial embarassment.

The Almaden Mine produced during the year 1890, 50,035 flasks of mercury. Its product in 1884 was 49,477 flasks. The product of other Spanish mines in 1890 was 1450 flasks. The ore of the Almaden mine averaged during the year a yield of 9.30 per cent. of the metal, while that of other mines in the Asturias, said to pay a profit, only averaged at 1 per cent. This statement exhibits the richness of the Almaden property in a strong light.

American Methods of Mining are to be studied by the Engineer-in-chief of the Paronai coal mines in Hokkaido, Japan. Mr. Losushiro Kawai, who accompanied by his assistant, Mr. Omajai, has come to the United States expressly to visit the Pennsylvania coal mines, and, if possible, to establish a market for Japanese coal in San Francisco.

Some Properties of Cast and Forged Aluminum Steel are extremely interesting to metallurgists, and a summary of the more important so far as they have been ascertained may be of service to many who have not time to read the somewhat copious literature of the subject. From an able and exhaustive paper read before the Iron and Steel Institute by Mr. R. A. Hadfield, such a summary is herewith compiled. The material experimented with in the determination of these properties was produced by melting in crucibles in the ordinary manner good wrought bar iron, and adding aluminum manufactured by the Pittsburgh Reduction Company's system, shortly before "teeming," to obtain an alloy or compound consisting as nearly as possible of aluminum and iron alone. In the material other elements present do not amount to more than 0.50 per cent. The ingots, 2½ inches square, were reduced by forging in the ordinary manner to bars 1¼ inches diameter. In casting, corruscation always occurred, as also observed in alloying aluminum with copper, and Mr. Hadfield seems to imply that this may indicate that iron-aluminum chemical compounds are formed instead of alloys in the commonly accepted sense. It is doubtful whether aluminum increases the fluidity of melted steel which has been properly made, but if so, Mr. Hadfield thinks the effect is due to the increased heat produced in the alloying or combination of the metals with each other. Annealed samples—0.85 per cent. aluminum, bent double cold; those unannealed were not so good. The gradual inincrease of aluminum is very clearly shown to reduce the toughness both of the unannealed and annealed specimens. They were sound with the exception of two samples, but not more so than cast silicon steel of corresponding percentages. As might be expected from the soft nature of the metal aluminum, its addition to iron does not add materially to the hardness,

in this respect resembling the effect of silicon. Seven to 8 per cent. cast aluminum steel may be readily drilled and filed, and the magnetic susceptibility of the iron is not affected by the presence of aluminum. As shown by fracture of cast specimens, the size of the crystals is increased. As high as 5.60 per cent. of aluminum may be present in forged aluminum steel before malleability ceases. The malleability is very satisfactory in steel low in manganese. Up to 2.24 per cent. aluminum the samples bend double while cold, but upon reaching 5 per cent. a great diminution of strength takes place, and annealing practically produces no effect. Tensile strength is less increased by addition of aluminum than by addition of silicon. The addition of aluminum does not confer appreciable hardness to steel either in the cast or forged state. In this respect such steel resembles silicon steel. The forged material containing 5 per cent. is very soft and easily drilled or filed. The action of aluminum may therefore be classed with that of silicon, sulphur, phosphorus, arsenic and copper, as giving no increase of hardness to iron, in contradistinction to carbon, manganese, chromium, tungsten, and nickel. When carbon is absent water quenching does not harden aluminum steel. Steel containing 1 per cent. of carbon and 1.5 per cent. of aluminum may be hardened sufficiently to scratch glass. Aluminum causes the tough percentages, both in the cast and forged material, to break with dark, fibrous fracture, similar to wrought iron of good quality, only much darker in color. In several of the tested tensile specimens a rough and ribbed surface is noticed, proving looseness of texture. Samples containing respectively 0.61 per cent., 0.72 per cent. and 2.20 per cent. of aluminum were found impossible to weld; and Mr. Hadfield suggests that it would be interesting to essay the electric welding of aluminum steel.

A New Channeling Machine has since the April issue of this magazine been introduced into the Runcorn Quarries in Cheshire, England. The machine is the invention of Mr. W. L. Saunders, the engineer who wrote the article in the April number entitled "Have we Neglected Quarrying?"

The Bar Channeler made by the Ingersoll-Sergeant Drill Co., and also the invention of Mr. Saunders has within the month successfully accomplished the channeling of slate. One of these machines is at work in the quarries of the Imperial Slate Co., at Wind Gap, Pennsylvania. The *Pen Argyl Index*, referring to this machine states: "As is well known to every one interested in slate mining as at present conducted, quarry operators are suffering great loss by having large quantities of good slate block rendered worthless by being broken to pieces by blasting. The Ingersoll-Sergeant Drill Co. of New York has succeeded in making a machine, which, after due trial, is found to meet all the wants and requirements. All interested in slate mining are invited to see it. It will undoubtedly revolutionize slate quarrying. Its use will be a saving of thousands of dollars every year at every quarry. It will lessen the expense of taking out blocks, and with the same number of working men a larger production of slate can be made."

A Deposit of Rare Marble exists in Northern Virginia a few miles from Mountville. The only quarry there is that of the Virginia Marble Co., which has produced many beautiful specimens of white, cream-colored and green marble. One of the veins is most remarkable in its color and texture. When polished it looks like alabaster, having a waxy appearance showing no grain or figure. Its color varies from bluish-white to a pink, some of the intermediate shades having just enough pink or yellow in them to give the marble when polished a flesh color. There is no point in the world where marble is found which is apparently so well suited for statuary work. A figure carved out of this material would have a remarkably life-like effect.

The Iron and Steel Output of France in 1890 has been printed in the *Ironmonger*, and the figures show that, as a steel producing country, France is rapidly gaining upon her competitors. Last year's product of pig-iron attained the total of 1,970,160

tons--an increase of 247,780 tons upon 1889, and within 100,000 tons of the maximum of 1883. The total output of finished iron was 823,360 tons, which is 30,000 tons above the preceding year's total, but no less than 250,000 tons below the maximum of 1882. On the other hand, the output of steel was the largest ever attained. The total, 566,197 tons, exceeds that of 1889 by 37,000 tons, and that of 1888 by nearly 50,000 tons. This rise took place in spite of a fall of 10,000 tons, as compared with 1889, in the production of bars. There was an increase of 30,000 tons in rails, and of 19,000 in sheets, etc. The largest producing districts were: For pig-iron, Meurthe-et-Moselle, 1,083,705 tons, an increase of 140,000 tons; for finished iron, the Nord, 340,056 tons, an increase of 18,000 tons; and for steel the Nord and Pas-de-Calais, 142,000 tons, practically the same total as last year. There was an increase of 17,500 tons in the steel output of Meurthe-et-Moselle, which amounted to 61,988 tons. This rise represents the growth which is taking place in that district in the manufacture of steel upon the basic process from the native ironstone deposits. The same district is making by far the most rapid advances of any French metallurgical centre as a producer of pig-iron.

The Schlesinger Ore Dock at Escanaba, Mich., connected with the Escanaba Iron Mountain and Western railway has recently passed into the hands of Eastern capitalists and will be controlled by the Northwestern railway. The dock will be completed about the time of our going to press. It will be the largest ore dock in the world, being 1422 feet long and containing 232 pockets of 180 tons each, capacity, making a total capacity of 41,760 tons, a capacity of over 6000 tons more than the largest dock in the United States. It is 52 feet high above the level of the water and is connected with the shore by a trestle 800 feet long. The dock has been constructed under the direction of Mr. E. C. Haledge, resident engineer, and is said to be built in the best manner and of superior materials selected by him. The contract for the construction was let to R. B. Dear, who has built all the coal and merchandise docks at the head of Lake Superior, both at Duluth and West Superior, erected during the last five years, and who has completed this great work in a very short time. Until between Jan 5 and 10, of 1891, no work was done either on the approach or dock above the sills, and over 7,000,000 feet of timber have gone into place, besides several hundred tons of iron since that time. A correspondent of the Milwaukee *Sentinel* asserts that Mr. Dear has also broken the world's record in hanging the car chutes, 232 chutes being hung by one single crew of eight men in seven and one-half days, an average of 31 chutes per day, but as high as 41 were hung in one day. Mr. A. R. McDonald, of Minneapolis, as superintendent for Mr. Dear, on his dock, has supervised the construction. Escanaba now has nearly double the capacity for handling ore of any other port on the chain of lakes. The Northwestern railway alone controls the entire shipment from this point.

The Death of Kit Carson, which occurred after our April number was printed, is an event worthy to be noted by all interested in the development of the "Great West," and its mineral resources. His part in the demonstration of the existence of this hidden wealth was a very important one. The writer vividly remembers the excited interest with which, as a boy, he read the narratives of the explorations of John C. Frémont, surnamed "The Pathfinder," (who deserved better of his country than he received) and how in all these accounts of prolonged hardship, unexcelled courage, and iron perseverance, the name of Kit Carson was spoken of—almost affectionately—as belonging to all that is manly, noble and admirable in human character. In truth, the work of these great men will never be forgotten. It pointed out the way for our transcontinental railways, and led to the discovery of our Californian mineral treasures without which our country could hardly have survived the shock of its great Civil War, and in the magnitude and importance of all its sequences, is comparable to any intercontinental exploration ever performed in the history of the world. The names of Car-

son and Frémont are so intimately connected that little can be said of the former without allusion to the latter. It will do us no hurt to pause a moment and recall what both have done for the development of this country. Had Carson had the advantages of early education that Frémont had, there is no great position in the gift of this country to which he might not have aspired. He was born great; great in heart, great in executive ability, and few men since the death of Washington have gone to the grave more respected and esteemed for unflinching truth and integrity.

Escanaba, Mich., at the head of Green Bay, is in many respects one of the most remarkable of our western cities. It will hardly be credited, but it is a fact fully substantiated, that this lake-port town—only five years ago a little village, and even now numbering a population of only 8000,—has an annual retail trade of $3.000,000, and a wholesale trade of $25,000,000, and that the freight capacity of vessels entering and clearing from its ports in 1890 was more than 8,000,000 tons or only 3,000,000 tons less than that of the port of New York. The bulk of this tonage is iron ore, pig-iron, lumber and coal. Of iron ore it shipped, in 1890, 3,700,000 tons, or more than double the total shipments of ore from all the other ore ports in Michigan, Wisconsin and Minnesota. Of lumber it shipped 120,000,000 feet. The general aspect of the town is peculiar, combining as it does many of the characteristics of small inland towns with those generally met with in large sea-ports. The Northwestern Railway controls and monopolizes the shipment of ore. The enormous ore-dock just completed for its use is elsewhere described in this department of this number. The town is lighted by electricity, has a well-organized fire brigade and an electric street railway will soon be put in operation. It would seem that Escanaba has a future, and that a man of enterprise might find something to do there.

English and American Blast Furnaces are to have a competitive trial at Jarrow-on-Tyne, where Palmer's Shipbuilding and Iron Company have erected a blast furnace of substantially the American type, a trial which, according to *Engineering* (London), will afford manufacturers evidence as to whether the American or Cleveland blast furnace practice is the more economical and satisfactory for the British producer, there now being much controversy on this point. The furnace is an exact copy of the most recent one at the Edgar Thomson Works of Messrs. Carnegie Brothers, at Pittsburgh—a furnace which has produced up to 2500 tons per week of pig iron, or more than double the output of the best English hematite furnaces, nearly five times as much as an ordinary Cleveland furnace, and almost twelve times that of the average Scotch furnace. The new Jarrow furnace is 76 ft. 2 in. in height, with a 20-ft. bosh and 11-ft. depth of well. It has four Cowper hot-blast fire-brick stoves, and is blown by a compound condensing engine having 100 in. blowing cylinders. In America it is not the practice to have one blowing engine to several furnaces as it is in England, but each furnace has its separate engine, and this will be the case with this new furnace. There are eight tuyeres made of bronze, the use of that metal for such a purpose peculiar to America, having not been before adopted in England. The blast will be driven into the furnace at a pressure of about 8 lbs. per square inch. In the United States the pressure is nearly 10 lbs., whereas in Cleveland it is only 5 lbs. to 5¼ lbs. On this account the furnace must be expected to produce a good deal more iron in a given time than the ordinary British hematite furnace, for it is to be fed with hematite ore, but it will not come up to the largest records in the United States, seeing it will have to smelt a 50 per cent. ore, whereas in America a 60 to 63 per cent. ore is used, which is also much less refractory than the Spanish ore generally used in England. When blowing at such a pressure something has to be done to preserve the brick-work from the extra heat, and the furnace is therefore encircled by rings of water tubing, 64 in number, through which 1500 gallons of water per minute are circulated.

The Seven Devils' Copper District, situ-

ated in Washington Co., Idaho, seems to have a boom impending. A correspondent of the Salt Lake *Tribune* says that the growth of this district depends upon the successful navigation of the Snake River to Huntington, 60 miles above Ballard Landing, and that the Snake River Navigation Company has had built a steamer of 300 tons to test its practicability. It is generally thought by those conversant with the peculiarities of the river that the steamer will prove successful. If the experiment succeeds the American Mining Company will at once push operations in its properties situated near Huntington. This company, capitalized at $5,000,000, is composed of Montana men, among whom are Messrs. Kleinschmidt, Heiderbrecht and Hauser, and owns the Peacock mine, which is the most important in the district. Mr. J. C. Rogers, of Huntington, Ore., is the resident manager of the company. He states that the company is building a wagon road, costing $18,000, from the mine to Ballard Landing. With the exception of the lower end, the road is now completed. It is 18 miles in length, although the distance between the mine and the landing is only four and one-half miles in a direct line. The maximum grade is 8% and the average 5%. A contract has also been let for the erection of a smelter of 50 tons' daily capacity near the Peacock mine. The company will employ 50 four-horse teams and 250 men this summer. There are now about 200 mineral locations in the Seven Devils district, many of them owned by wealthy companies, which are able to develop them. The mineral belt is about six miles wide, and runs parallel with the river, which is its western boundary.

Hard Times for English Ironmasters is now the cause of anxiety among them, and from a review of existing conditions very little encouragement for the immediate future is to be gathered. As a specimen of the prevailing feeling, the following expression of it is taken from a paper published in Sheffield: "The signs of the times are all against them. Everybody seems to be playing a waiting game. A spurt in the shipbuilding trade would be a great boon but there is no likelihood of it as yet. The important carrying industry is not in a state to encourage additions to the merchant fleet. There is uncertainty, too, in regard to the coal field. The miners, it is feared, may cause trouble. Without confidence as to the future, business men hesitate to take in hand new work. As a leading authority was heard to put it this week, 'Trade is being frightened.' Pig iron can now be bought at 58s. 6d. per ton, delivered in Sheffield. Such a low price has not been reached since April of 1889. At such a figure iron cannot be made with profit. Thus the hopeful aspect of last year is being gradually clouded over, and the outlook gets gloomier every day. Nor is it only in the iron industry that languor prevails. The collapse in the Argentine Republic has been so disastrous that the railway material trade, for which that country was the chief customer, has been partially paralyzed. There is, happily, a fair business in railway material with other markets. Although the exceptional call for war material, chiefly in armor plates, has now ceased, there remains work in hand adequate to keep the mills going for this year at least."

The Centennial of the United States Patent System, celebrated last month in Washington, has been an interesting event, and in connection with it the following statistics illustrating the growth of the system are of interest. The issue of patents from 1837 to March 31, 1891, numbers 444,652, and as 10,000 patents were issued prior to the serial numbering of patents as issued, the total issue up to the date named was 454,652. Of course a large proportion of these inventions have for various reasons been of little or no benefit, either to their inventors or to the public, but out of the struggle for advancement, stimulated by the system of patents the law of the survival of the fittest has developed in the aggregate a glorious progress of which the country may well be proud, and the continuance of which is sure. This progress, as it will be seen at Chicago, will, compared with our showing at the Centennial of 1876, not make us ashamed, though we did well then.

THE Word Bronze is derived from "Brundusium" or Brindisi. This opinion having been expressed by M. Berthelot is asserted by *Nature* to have been confirmed by the discovery of a passage in a document of the time of Charlemagne, where reference is made to the "composition of Brundusium"; copper, two parts; lead, one part; tin, one part. It would appear that at Brundusium bronze was in ancient times manufactured on a great scale.

Castor Oil as a Lubricant has been made the subject of exhaustive experiments by the Italian Government, and it has now ordered that all exposed parts of machinery employed in government work be lubricated exclusively with castor oil, while mineral oils are to be used for cylinders and similar lubrication.

Leather Brake Shoes made of waste leather scraps steeped in a softening solution and subjected to hydraulic pressure sufficient to mould them in the shape desired, have been tried for railway service in New South Wales. The co-efficient of friction is so much greater than that of iron that 40 pounds of air pressure are as effective as 70 pounds with iron shoes. The leather shoes weigh 4½ pounds, as against 21½ pounds for the iron shoes.

An Instructive Story, as well as an amusing one is told by Mr. Ambrose Webster, who for thirty years was superintendent of the Waltham Watch Works, and who was once a railroad mechanic. The incident occurred on the Richmond and Danville Railroad in 1853. He jacked a locomotive up and took out her wheels without shoring up on each side and at the ends of the boiler, and got discharged for it—master mechanic said the boiler might have tipped over. The *Locomotive Engineer* remarks upon this that "if he jacked up an engine and *did* prop up the boiler now, he would probably have to take a walk just the same."

Twisted Wire Nails are one of the novelties of modern progress, and though they are inserted by driving, they look much like screws. The invention is of English origin. Its crushing action upon the wood in driving it, is claimed to be less injurious than that of either the cut nail or the straight pointed wire nail; while it is claimed to hold stronger than either. This nail must not be confounded with the new American invention of a screw which can be driven in with a hammer and turned out with a screw-driver; as, though akin to this screw, it is distinct from it, and cannot be extracted in the same manner. In fact, from accounts of those who have tried it, its extraction by any means is a somewhat difficult operation.

Chief Engineer Sewell of the White Star Line, has, it is stated, sailed 818,400 nautical miles or 941,000 English miles, and, in consequence, may lay claim to be one of the greatest travellers in the world on the score of distance travelled.

The Man who Pays the Bills for fuel, oil, repairs and attendance in the generation of steam-power will find a valuable aid in reducing them to a minimum in a

little volume just issued by the Cassell Publishing Co., 104 and 106 Fourth Ave., New York, and entitled "Hints to Power Users." The author is Mr. Robert Grimshaw, M. E., a well-known and acceptable writer on mechanical subjects for technical publications. The book, however, is written in the plainest possible language, nearly devoid of technicalities and entirely free from mathematical discussions. Any one may read it easily, and in it many power-users, now chafing at the extent of their expenditures may find a straight path to economy.

To Remove Oil, Paint, Varnish, etc., which even strong lye will not remove, Doctor Stockmeier employs, with much success, a mixture of ammonia, 2, and oil turpentine, 1, which, when well shaken yields an emulsion having the property of very quickly softening the paint, etc., when it can be removed with a cloth.

The Carpenters' Plane proves to have been a very ancient tool if, as is stated, it be true that in excavations at the Roman city of Silchester a dry well was opened and among other curious things found in it there were carpenters', silversmiths' and coppersmiths' tools, all of which it is supposed must be at least 1500 years old. Among these was a carpenter's plane of quite modern type. There were also chisels, gouges, saws, adzes, hammers and files. One thing that suggests a doubt about the antiquity of this find is, that the tools are stated to be of iron, a metal whose tendency to rapid oxidization seems almost to preclude the possibility of so long a preservation under the conditions in which they were discovered.

A New System of Engraving for illustration of mechanical subjects, such as machines or engines requiring front and back views, is adopted in the *Manufacturer and Builder* for March, in a description of a wood-working machine. The photograph for the engraving was taken by placing an inclined mirror behind the machine in such manner that the reflected images of the rear and the front were photographed simultaneously; and also in such manner that the photograph of the rear is brought into a position as though it were suspended just over the front view. The relations of the parts are extremely easy to interpret, and this example shows that the method is well-adapted to delineate machinery satisfactorily where the object sought is to impart a clear understanding of parts and their functions, rather than to make a simple picture.

The Life of Steel Cars is said to average twenty years, while wooden cars are used up in eight years. The Dayton *Evening News* states that "a steel mail car in use between Chicago and Louisville has received even more than the ordinary share of encounter with accidents that fall to the lot of American railway trains, yet it has stood its ground without being smashed or even damaged by more than mere surface scratches. The repairs on wooden cars are estimated as ten per. cent of the average current running expenses of American railways. The repairs of steel cars are comparatively merely nominal. This makes out in brief a rather strong case in favor of steel cars.

Automatic Couplers of the type adopted by the Master Builders' Association have been placed on the freight cars of companies controlling in the aggregate over 72,000 miles of road. Over 99,000 freight cars are reported to have been equipped with these couplers at the beginning of the present year.

Eccentricity in the Running of Spindles has been very intelligibly explained by a writer in the *American Machinist*. We do not remember seeing the subject more clearly handled. The explanation follows: "The holes in the spindle-boxes are one one-thousandth of an inch larger than the spindle bearings. When a bearing is oiled, and the spindle is running, the oil is about equally spread over the bearing. But when the spindle stands still for a few minutes it settles, so that the under side of the bearing touches the box, and the oil is forced to the top. Now, when the spindle is started up an eccentric of oil is carried around by the bearing, and a cam of oil is held by the box, and, until the oil is distributed, the spindle does not run true. The spindle will often run out of true for eight or ten turns. Upon stopping the spindle

the indicator at once shows that it is settling down through the oil. If the boxes are not in line the spindle bearings may be held to one side, so that the spindle cannot settle, and there will be no oil eccentrics or cams that will have any effect. If a spindle does settle, upon being stopped, we have evidence that the boxes are in line. In starting up a planer or a grinding machine, in the morning or afternoon, it is often well to take the precaution to make a few strokes before beginning to cut. A planer table takes a different position, after standing for awhile, and if the tool is allowed to cut on the first stroke after starting, it leaves a mark. This especially holds in taking a finishing chip. Some planer men will not begin a finishing chip unless there is time to carry it across before the power stops.

Recruits for the Steam Engineering Service in the United States Navy are hereafter to be provided with a school of instruction, which it is announced the United States Navy Department will organize aboard the *Miantonomah* soon to be put into service. It has been found wholly impracticable, through the ordinary method of enlistment, to secure the requisite skill, and the wise course of training recruits before employing them in actual service, has therefore been adopted. The perpetuation and extension of this system is probable and great resulting improvement in the force may be confidently counted upon.

A Circular Saw that also Planes has attracted sufficient notice in Glasgow, Scotland, to be mentioned in the press of that city as something quite remarkable. This saw having been exhibited at the Glasgow East End Industrial Exhibition by a Nottingham (England) firm, is spoken of by a Glasgow paper as "One of the simplest, although perhaps the most interesting exhibits in the mechanical section, which cuts and planes all kinds of wood by the same action as an ordinary circular saw, producing a beautiful smooth surface, equal to hand-planing, with little additional power and no more labor than is required for ordinary sawing." Our Glasgow friends are hereby informed that this kind of saw is of Yankee origin, and has been well known to workers in wood for a considerable period in this country, having been much used by clock-case makers and manufacturers of wood types. A circular saw with a stiff body, tempered so that its teeth can take good cutting edges and made thinner at the arbor than at the edge, or double concave, will, if properly sharpened and jointed, plane as well as saw.

The Patent Centennial, as was anticipated, has proved a very interesting and important event. We are indebted to the courtesy of Edward F. Fenwick, Esq., of Washington, D. C., for a list of the officers of the National Association of Inventors and Manufacturers, which was one of the most important results of the convention, and for the information that the addresses of the eminent men delivered during the different sessions will be published in book form. The constitution and by-laws of the new association will also be printed and ready for distribution in a short time. Annual meetings will be held. The officers for the ensuing year are: President, Dr. R. J. Gatling, of Hartford, Conn., the inventor of the celebrated gun which bears his name. Vice-Presidents, Dr. Gardner G. Hubbard, of Washington, D. C.; Prof. William A. Anthony, president of the American Institute of Electrical Engineers; Thomas Shaw, Esq., Philadelphia, and Hon. Benjamin Butterworth, Ohio, former Commissioner of Patents, ex-Chairman of the House Committee on Patents, and now Secretary of the Columbian Exposition. Secretary, Prof. J. Elfreth Watkins, Curator at the National Museum. Treasurer, Mr. M. C. Stone, of Washington. Board of Directors, John Wise Smith, Esq., engineer, Pennsylvania; David G. Weems, Esq., Maryland; Prof. R. H. Thurston, of Cornell University, New York; Chas. F. Brush, Esq., Ohio; Prof. Otis T. Mason, Curator, National Museum, Washington, D. C.; Hon. David M. Smith, New Hampshire; F. E. Sickels, Kansas City, Missouri; Oberlin Smith, Esq., New Jersey, and R. S. Munger, Esq., Alabama. In addition to the regular officers and board of directors, there will be representatives in every State, some of which have already been appointed. At an in-

formal meeting it was suggested that there be a committee of seven on legislation to advance the interests of the Patent System before Congress and guard against any encroachment upon the rights of inventors and manufacturers.

A New Car-Journal Oiler tried on the Norfolk & Western Railway has given good results, to wit, 4896 miles with the consumption of only one pint of common black oil for a journal 3½"x7½". The *Railroad Gazette* describes this oiler as consisting of three pieces of felt, held together by a brass band with a small sheet clip to prevent the felt falling down. The pieces of felt are pressed against the journal by springs at the end. The whole device is so constructed as to be inserted in the standard oil box without alteration of that box. With this method of oiling only the pure lubricating substance can reach the journal. The pressure of the journal on the centre wick, which wipes the journal, prevents the side wicks, which are the oilers, from becoming gummed.

The New French Steam-Carriage designed by M. Serpollet, has attracted much attention in Paris and it appears to approach more closely the requirements of a steam propelled vehicle for ordinary roadways than anything that has preceded it. Somewhere about 1870 the late Mr. Richard Dudgeon, inventor of the famous hydraulic jack, a favorite form of tube expander, and other valuable improvements that have made his name familiar to American engineers, exhibited a steam carriage on the roads of Central Park. The writer was present and took a long ride in the vehicle. It seemed to possess nearly or quite all the good qualities claimed for M. Serpollet's carriage but it probably appeared before the time was ripe for its introduction. It is doubtful that the state of the roads in the United States is such at the present time as to encourage steam propulsion upon them, but as French roads are of the best in the world, M. Serpollet may have a better opportunity to exploit his invention than has yet fallen to the lot of American inventors. The new French carriage is said to be roomy and comfortable for seven passengers (Mr. Dudgeon's seated eight). It would probably be classed as a phaeton. In case of rain a hood in front can be put up, as in other phaetons. The generator is concealed from view, being placed in the rear between the two coal boxes, with which it is connected by two passage ways, through which the fuel is fed automatically. The chimney is inverted, and a second chimney, used only for firing up, is carried in a box. The water tank is placed under the seat to the left. The supply of fuel and water is too limited for best practical results, which seem only possible by the employment of a tender; and as the engines develop four to six h. p. this would seem perfectly feasible in making long runs, as the weight of the vehicle is about 3000 lbs. The capabilities of the carriage are shown by the fact that with its load of passengers it has ascended gradients of eight centimeters per meter over heavy roads charged with pebbles. Firing up is effected as in ordinary stoves, and in twenty minutes everything is ready for the trip. The starting is effected by means of a hand-pump. The water introduced into the generator instantly vaporizes and the carriage begins to move. The feeding continues automatically. The steering handle serves also to regulate the speed. It is capable of making a rotary motion upon its axis, and of opening and closing an orifice for the return of water to the tank. Only one hand is required for steering. Stoppage is effected by cutting off the feed. The most sudden stoppage is effected through a brake with a pedal placed within reach of the driver's foot. It is perfectly possible to travel during the darkest night with a single lamp for lighting the roadway. A point with this carriage is that when it is running at a level or up or down-hill the pressure, without one's having to occupy himself with the apparatus, remains stationary or descends or rises of itself, according as the motor meets with greater or less resistance. A simple supplementary injection with the hand-pump suffices to obtain this effect. The pressure rises, the quantity of steam produced increases and the additional stress is exerted.

FOREIGN Representation at the Columbian Exposition does not seem to have been discouraged by the enactment of the new tariff law, as was predicted by many croakers. Neither have some other unfortunate complications had the deterrent effect which was expected at the time of their occurrence. The prospects of a good showing from different nationalities increase as the exposition approaches realization. In Berlin a committee has been appointed by a conference of German manufacturers, and authorized to supervise, facilitate and arrange an adequate exhibition of the products of German industry. The British Government has formally accepted the invitation to take part in the display, and indications of a world-wide interest in the success of the exposition are daily accumulating. Permission has been asked by Tochi Takimine, of Tokio, for the privilege of erecting a number of buildings in the Japanese style, in which to make an exhibition consisting of a Japanese tea-garden and restaurant, and a hall with seating capacity for the display of Japanese dancing and other Oriental exhibits. The buildings, as proposed, are to be decorated in Oriental fashion, and adorned with a rich collection of Japanese plants and flowers. The Austrian manufacturers are also taking concerted action and are urging upon the government the necessity that they also take part in the exhibition.

Microbes Put to Service, is as good a title as any to the following remarkable statement made upon the authority of Doctor Neilson of Norway. A few miles from the town of Bergen there is a narrow inlet of the sea, into the mouth of which whales make their way every season. When a whale is discovered in this place, the alarm is given, the fishermen put out in their boats, drive the whale farther up the narrow bay, and stretch a net across the mouth of the inlet. Through this the monster could easily break, but he does not. Then they proceed to capture him and bring him to land. The animal, however, is twenty or thirty feet long and very strong, and with their primitive implements alone this cannot be done. They therefore inoculate the whale with the poison of an infectious disease, and only after he is weakened as the result of the disease do they try to kill him. After the whale has been inclosed, the bowmen put out, and, when he comes to the surface to breathe, they shoot infected arrows into him and withdraw. After twenty-four or thirty-six hours the whale becomes less lively in his movements, and comes to the surface often to breathe. Then the real battle begins, and, after driving ten or twelve harpoons into the whale, the fishermen are able to land him. Doctor Neilson thinks the disease thus imparted to the whale is anthrax, because in the wounds made by the arrows, bacilli closely resembling those of sympathetic anthrax in land animals are found.

Mosquitoes Put to Service in the Prevention of Yellow Fever, by Drs. Finlay and Delgrado of Havana, is the burden of a curious announcement in the *Lancet* (London). These physicians have for the last ten years practised inoculating per-

sons newly arrived in Cuba against yellow fever by means of mosquitoes which have been caused to contaminate themselves by stinging a yellow fever patient. Fifty-two cases have been followed up and the effects of the inoculation carefully studied. Of these, twelve experienced between the fourth and the twenty-sixth day after inoculation a mild attack of yellow fever, with or without albuminuria; twelve experienced no symptoms of yellow fever either within twenty-five days after the inoculation or during three years subsequently; twenty-four experienced no symptoms within twenty-five days, but contracted a mild attack before the end of three years, either uncomplicated by albuminuria altogether or with only a very transient appearance of it; three who had had no symptoms within twenty-five days contracted well-marked yellow fever within three years; one patient who had a mild attack in consequence of inoculation contracted a severe attack later on, which proved fatal; that is to say, that of those who had been inoculated, only about 8 per cent. contracted the disease in a well-marked form, with a mortality of under 2 per cent. Of sixty-five monks who from time to time arrived in Havana, where they all lived under similar conditions, thirty-three were inoculated and thirty-two were not. Only two of the inoculated contracted well-marked attacks, which, however, did not prove fatal, whereas eleven of those that had not been inoculated were severely attacked, no less than five dying.

An Innovation in Transportation by Water, is the use of tank steamers for shipping molasses in bulk, after the manner of shipping petroleum. Two steamers have been chartered for this purpose (according to current report), to transport molasses in bulk from Cuba to the United States. By this system it is expected to make a notable saving to the importer in a number of important expenses incidental to shipping in casks, as stevedore's fees, cooperage, etc., etc. The method seems perfectly feasible, and in view of the success which has attended the shipment of petroleum in bulk, the wonder is that it has not been sooner thought of as practicable for molasses.

Prevention of Narcotic Inebriety was made the subject of discussion and of a series of unanimously adopted resolutions at a recent meeting of the Society for Cure of Inebriety held at the Academy of Medicine, New York. The resolutions were presented by Dr. J. B. Mattison, of Brooklyn, and recite, in substance, that whereas the principal cause of narcotic inebriety inclusive of morphinism, chloralism and cocainism, is the facility with which these drugs can be obtained from pharmacists, and that the refilling of prescriptions containing them is a potent factor in causing these diseases, it be resolved as the sense of the association that morphine, chloral and cocaine should be retailed not only as heretofore on presentation of a physician's prescription, but should be *refilled* only upon a written order by a physician.

An Interesting Discovery has been made on the Harnhalli gold mine in the Mysore, says the *Indian Engineer*. While sinking the main shaft the workmen broke into an old shaft, dug, perhaps, a thousand years or more ago. There were found mining implements of various kinds used by the ancient workers. It is supposed the workings were made by Chinese, of whose presence in Mysore there is unmistakable evidence. The tools found are said to be very like those used by the Chinese and unlike anything known to be used by Hindus.

Bleaching Powder is a new manufacture in Russia, where it has been begun at Elabouga, in the province of Viatka. Hitherto all the bleaching powder needed for use in Russia has been imported, a quantity said to be 10,000 tons annually. The Leblanc process for the manufacture of soda-ash will shortly be installed at the same place.

The Submarine Cables of the World, owned by twenty-six companies, are estimated to represent in round numbers, a capital of $200,000,000, from which is derived an annual revenue of $15,000,000; and all this enormous interest had its beginning in 1851, in the cable laid been

Dover, England, and Calais, France. A writer in a foreign periodical, has named as the most remarkable feat in the history of telegraphy the transmission via cable of last year's Derby from Epsom to New York in fifteen seconds, or almost before the winning horse could check his motion after passing the post. Such wonders are now getting so common that only by pausing to reflect, we realize that we are surrounded by them.

A New Departure in Steam-Yacht Building is exemplified in the steel steam yacht now in course of construction for Mr. J. M. Forbes at the Atlantic Works, Boston, which is to be fitted with a centreboard. This is the first steam yacht so fitted. The centreboard is expected to serve two purposes—to steady the yacht in a seaway, and to keep her from making leeway when under canvas.

Demand in Excess of Supply is sending up the prices of two substances at the present time at such a rate, that unless good substitutes can be found for them, their cost must before many years elapse become almost prohibitive. These substances are platinum and gutta percha. The extensive use of these substances in electric engineering, has been the chief cause of the rapid advance. As an insulator for cables no substance has yet been found that can completely replace gutta percha. Platinum is used in every electric lamp, and though the quantity is small for a single lamp, the aggregate amount is taxing the limited sources of supply to an extent that has increased its price six-fold in five years. The price of platinum per ounce is not far from that of gold, and there is every indication that higher prices are to be expected.

The Vitality of Southern Industry is evinced by the fact that in the first three months of this year there were established 853 new industrial enterprises as against 837, in 1890, and 612 in 1889. The new enterprises for this year as given in the *Tradesman's* report include 6 agricultural implement works, 6 barrel factories, 12 boot and shoe factories (a comparatively new industry in the South, only 2 having been established in the first quarter of 1890 and one in the first quarter of 1889), 3 breweries, 1 bridge works, 2 car works, 10 canning factories, 45 cotton and woolen mills (which is somewhat below the number established in the corresponding quarter of 1890; but the distribution is general—Georgia leading with 12, South Carolina 8, Texas 7, and nearly every other Southern State being represented). 58 large development and improvement companies organized (Texas leading with 12, and Alabama with 10) 31 electric light companies organized, 22 flour and grist mills, 47 foundry and machine shops, against 43 in 1890, and 45 in 1889; (Texas leading with 10, Virginia 9, and the balance being equally distributed) 9 blast furnaces organized, against 23 in the corresponding period of 1890, and 17 in 1889, 7 gas works organized, 28 ice manufacturing plants, 53 mining and quarrying companies incorporated, 4 nail works, 8 oil mills, against 21 in the corresponding period of 1890; 5 potteries, 1 rolling mill company, 53 street railway lines incorporated, 12 tanneries, 32 water works chartered, 141 wood-working plants, and 79 miscellaneous industries. The phosphate excitement is stated to be such that 32 new companies were organized during the quarter, 19 of which were formed in Florida. The extraordinary activity in railroad building in the South, is evidenced by the fact that during the three months 93 new railroad companies were incorporated; 13 in Virginia, 13 in North Carolina, 12 in Georgia, 10 in Alabama, 7 each in West Virginia, Texas, and South Carolina, 11 in Tennessee, and the balance in other States.

A School of Water-Spouts is described as having occurred on a recent voyage of the *Lock Eck* from Philadelphia, Pa., to Hiego Japan, by Captain Pettenridge, master of that vessel. The phenomenon occurred on the 24th of January. All at once the ship was tossed on the waves of what had the appearance of a gigantic whirlpool, and it was soon in the midst of a school, so to speak, of water-spouts, which moved rapidly about the ship in erratic directions. He describes one of these spouts as being 300 feet high, whirl-

ing in one direction, while there was apparently another inside of it whirling in an opposite direction. The spouts having all disappeared except one of monster size, an electric discharge from a supervening cloud seemed to make a conductor of it, and running down toward its base, the disruption of the water-spout took place with a loud report. It is highly probable that water-spouts and cloud-bursts will ultimately be found more or less intimately connected with electrical conditions of the atmosphere.

Florida as a Future Source of Camphor has good prospects, according to Professor Maisch, who in a paper read before the Philadelphia College of Pharmacy, stated that the camphor tree thrives in Florida, and seems to do so well on any kind of soil, that before ten years there will be more camphor than orange trees in that State. The quality of the gum is more like Japanese than Chinese camphor.

Manufacture of Smokeless Powder in Germany will, it is stated, be hereafter conducted under the supervision of engineers and chemists possessing the special knowledge and training necessary to successfully direct the processes and tests, for which high scientific attainments are said to be necessary. The superintendents of the powder factories at Spandau—hitherto artillery officers—will be replaced by civil-engineers and chemists.

The Oyster, dear to the heart of the epicure, is also interesting in other ways. In the first place he never stops eating during the entire term of his natural life, or until he is himself eaten, or captured for that purpose. His life being thus (whether waking or sleeping) one continued round of gastronomic enjoyment, it is meet that the succulency thus acquired should minister to the delight of the human palate. The way he eats and what he eats has been pleasantly told by Dr. H. Newell Martin, Professor of Biology at the Johns Hopkins University. It will please some people to know that he is as strict a vegetarian as a Buddhist. The hourly, daily and constant diet of the oyster consists of tiny plants which find nourishment in the mud and multiply with inconceivable rapidity. The professor tells us that in its native habitat the oyster rests "with its shells always a little apart and microscopic waving hairs set up currents which carry the food-plants to its mouth, where they are engulfed and afterwards digested. The oyster feeds every hour, every minute of the day, and turns material otherwise unavailable into one of the best of human foods."

The "Dynograph" is the name of an improved apparatus or car fitted with various registering appliances which, drawn over a railway, detects and records every imperfection in the track. The slightest spreading of the rails, unevenness of surface, any defect in the bedding of the ties, faults in the joints or looseness of the rails on the ties is automatically detected and recorded, so that both the precise points where repairs are needed and the nature of the repairs are detected and registered.

Curious Physical Anomalies have been from time to time discovered in the properties of India rubber. Tyndall in his celebrated treatise on "Heat as a Mode of Motion" points out that this curious substance is a law unto itself in the matter of its behavior when heated. Unlike nearly all other bodies, it contracts when heated. The *India Rubber World* in its April number calls attention to a curious behavior of rubber as regards its elasticity. The journal quoted says that "if a strip of gum rubber be heated, then expanded and quickly wound round and round upon a metal tube or wire and then cooled for a short time in cooling mixture, it immediately loses all of its elasticity and has no tendency to contract. If, however, it is then put into hot water, it at once regains its elasticity and returns to its original length. Another way of observing this same phenomenon is to hold the heated rubber a second in an expanded condition when unvulcanized, when it will retain its shape. If, however, it is now immersed in hot water, it contracts to one-fourth or one-fifth of this length, and will remain contracted to one-third or one-fourth of its original length. These are what may be called the secondary effects of elasticity."

At the Naval Exhibition to be held in London some ship's lanterns will be shown fitted with lenses designed and patented by Captain A. J. Loftus, of the Siamese service, formed by enclosing a layer of colored glycerine between ¼ in. panes of plate glass. It is found that the colors are more vivid than with ordinary lenses, red being distinguishable at 9000 yards and green at 6000 yards. They are practically unbreakable and it is expected that they will be adopted for the electric light signal lamps which are now used for various systems of signalling between ships at night. A model of the famous Eddystone Light-house will be in every way an exact reproduction of the new Eddystone Light-house itself. It is to be 167 ft. 6 in. in height and the light to be used is a single arc lamp of 5,000,000 candle-power.

Alloys of Aluminum with Copper were alluded to in a paper on Aluminum Steel, read before the meeting of the Iron and Steel Institute by Mr. R. A. Hadfield, and the following valuable tabulated statement of properties of aluminum bronzes from tests, the results of which were presented to the British Association by Mr. John H. Dagger, is extracted from Mr. Hadfield's paper:

		Tensile strength in tons per square inch.	Elongation.	Density.
			Per cent	
Aluminum bronze...	11 per cent. Al	40 to 45	8	7.23
	10 "	33 " 40	14	7.69
	7½ "	25 " 30	40	8.00
	5-5½ "	15 " 13	40	8.37
	2½ "	13 " 15	50	8.69
	1¼ "	11 " 13	55	....

The brittleness of alloys above 11 per cent. prevents their use. Those containing 60 per cent. to 70 per cent. aluminum are very brittle and beautifully crystalline; with 50 per cent. the alloy is quite soft, but under 30 per cent. the hardness returns. The 20 per cent. bronze has a whitish yellow tint, somewhat resembling bismuth, but is very brittle, and can be pulverized in a mortar. One of the most valuable properties of the alloys given in the table is that of being forgeable and capable of being worked at red heat. The percentage of elongation in Mr. Dagger's tests differs materially in the alloys containing more than 10 per cent. and upwards of aluminum from those made by Professor Tetmayer of the Polytechnic School at Zurich, as will be seen from the following transcript of Professor Tetmayer's results:

	Aluminum.	Tensile strength in tons per square inch.	Elongation.
	Per cent.		Per cent.
Aluminum bronze....	11.50	52	0.50
	11.00	44	1.00
	10.00	42	11.00
	9.50	40	19.00
	9.00	37	32.00
	8.50	33	52.50
	5.50	28	64.00
Aluminum brass.....	4.00	45	6.50
	3.00	39	7.50
	2.50	34	20.00
	2.00	31	30.00
	1.50	29	39.00
	1.00	26	50.00

Professor Tetmayer has plotted his results, the curve obtained showing that with increasing aluminum content the tensile strength increases slowly at first, but then grows rapidly as the alloy is made richer in the lighter metal.

The Basic Process of steel manufacture was made the subject of discussion at the last meeting of The Alabama Scientific and Industrial Association at Anniston, Ala. Professor Phillips, secretary of the association, gave it as his opinion that the process will soon be in extensive use throughout the Southern iron districts and asserted that royalties upon it cannot be collected. This opinion was confirmed by Mr. B. F. Peacock in a paper on The Future of the Iron and Steel Industry in Alabama on the ground that even if the payment of royalties on the existing patents cannot be resisted there are substitutes for the basic furnace linings outside of those covered by the Steel Patent Company's rights, the use of which will save the $1 per ton royalty. We have not learned that Mr. Peacock definitely stated what the substitute or substitutes are by which he so confidently hopes to evade paying the royalty.

Danger in the Use of Gas Stoves is pointed out in a lecture delivered before the Society of Arts (London) by Prof. Vivian B. Lewes, from which the following is quoted: "There is no doubt that gas is the most convenient and in many ways one of the best forms of fuel for heating and cooking purposes, and the efforts which all large gas companies are now making to popularize and increase the use of gas for such purposes will undoubtedly bear fruit in the future. But before the day can come for gas to be used in this way on a large scale, there is one fact which the gas manager and gas-stove manufacturer must clearly realize and submit to, and that is that no gas stove or gas water-heater, of any construction, should be sent out or fitted without just as great care being taken to provide for the carrying away of the products of combustion as if an ordinary fuel range was being fitted. Do not for one moment allow yourself to be persuaded that, because a gas stove does not send out a mass of black smoke, the products of combustion can be neglected and with safety allowed to mingle with the atmosphere we are to breathe." The lecturer adds that such physical discomfort is "caused by the use of gas to many delicately organized persons that a large class exist who absolutely and resolutely decline to have gas as an illuminant or fuel in any of their living rooms; and if the use of gas, more especially as fuel, is to be extended, and if gas is to hold its own in the future against such rivals as the electric light, then those interested in gas and gas stoves must face the problem, and by improving the methods of burning and using gas do away with the present existing serious drawbacks to its use.

Reversing Car Seats by a coin operating device which unlocks the seat is the subject of a patent by a Californian mechanical genius. The *Locomotive*, which notices this invention, remarks upon it that "with a device like this in use for lights, the use of the drinking cup, and the occupation of the toilet-room, the companies might possibly get along without asking fare. If some inventor will get up a device that requires the insertion of a four hundred dollar bill before a farm hand, with a Buffalo overcoat, and two drinks of whiskey, can open a car window in front of a woman with a sick baby, we will head a list of 'eminent citizens' that will build him a monument nine hundred and eighty-four feet high."

A New and Promising Fuel solidified from petroleum has been produced. *Indian Engineering* says that experiments have been made at the Rangoon oil refinery with a view of obtaining a cheap and solid fuel from petroleum, and a very good result was obtained by heating the oil and dissolving three per cent. common soap. The product is found hard to ignite, burns slowly, causes barely any smoke, and produces great heat. It is claimed to be a clean and convenient fuel and superior to all other fuel obtained from mineral oil.

Eat Before You Sleep is the advice of most medical authorities at the present time to "brain-workers." To go to-bed fasting is the fruitful cause of sleeplessness and nervous prostration. The brain exhausted by work—especially evening work—demands some nutritious, easily digestible and assimilable food. The following articles for a night-cap lunch are recommended by an eminent medical writer: A bowl of stale bread and milk, of rice, or some other farinaceous food, with milk or hot soup, any of which will insure a sound night's sleep, from which a man will awaken refreshed.

Cement made from the dust of ordinary hard-burnt bricks, pulverized for the purpose and mixed with lime and sand, is used in Spanish countries as a substitute for hydraulic cement. It is asserted on the authority of an engineer who—during six years residence in Cuba—had ample opportunity for testing it, that it is superior to Rosendale cement for culverts, drains, tanks, cisterns and roofs.

Rich Deposits of Petroleum, easy of access, known for some time to exist on the east coast of Sumatra, are soon to be worked by a Dutch company which has been formed with a capital of 1,300,000 florins. Previous attempts to secure capital to work these deposits have failed.

OUR EXCHANGE TABLE.

EDITORS and publishers are requested to send marked copies of special publications for mention in this department. The list of articles is still not so complete as we purpose to make it, for reasons that will readily suggest themselves.—ED.

IRON AND STEEL: *w.* 6d. London. March. Some Recent War-Ship Designs for the American Navy. The Nickel and Copper Deposits of Sudbury District, Canada. (Illustrated.) Mr. Robert Bell. April 3. Recent Trials of Rock Drills. Mr. E. H. Carbutt and Mr. Henry Davey. Boiler Construction for Withstanding Strains of Forced Draught. Mr. A. F. Yarrow.

THE IRON AGE: *w.* 10c. New York. April 2. Our Copper Resources. Mr. James Douglass. (Continued.) Manufacture of Seamless and Brazed Copper Tubes. (Illustrated with Supplement of Engravings.) Aluminum in Railroad Work. April 9. The Calculation of Blast Furnace Slags. (To be cont'd.) April 16. Calculation of Blast Furnace Slags. A. J. Rossi. (Cont'd.) Circulation of Water in Steam Boilers. (Illust'd.) Our Copper Resources. (Cont'd.) James Douglass.

THE RAILWAY REVIEW: *w.* $4 per year. Chicago. April 4. Improvements in Locomotive Boiler Construction. Mr. John Hickey, Supt. Motive Power Northern Pacific R. R. (Illust'd and cont'd.) April 18. The design of Railway Stations and Yards. R. M. Parkinson, C. E.

RAILROAD GAZETTE: *w.* $4.20 per year. New York. April 3. Test of Steel Tires. E. Roussel, Engineer-in-Chief of the Belgian State Railroad Laboratories. April 10. The Oil-Mixing Plant of the Lehigh Valley Railroad. Mr. C. P. Coleman, Chemist, L. V. R. R. (Illust'd and cont'd.) Railroads in China.

THE RAILROAD AND ENGINEERING JOURNAL: *m.* 25c. New York. Development of the Compound System in Locomotives. Mr. M. A. Mallet. (Illust'd and cont'd.) The North Baltic Ship Canal. (From the German. Illust'd and cont'd.) Submarine Mine and Torpedo Harbor Defense. (Illust'd and cont'd.) Our Navy in Time of Peace. (Cont'd.)

THE MINING JOURNAL: *w.* 6d. London. Seven Centuries of Tin Production in the West of England. Mr. J. H. Collins, F. G. S.

THE MARINE ENGINEER: *m.* 6d. April. Some Details in Marine Engineering. Thomas Mudd, Esq. Marque's Adjustable Bladed Propeller. (Illust'd.)

ENGINEERING: *w.* 6d. London. March 20. The Compressed Air System of Paris. (Cont'd.) Modern French Artillery. (Illust'd and cont'd.) The Clarence Bridge Over the River Taff. (Illust'd and concluded.)

THE ELECTRICIAN: *w.* 4d. London. April 3. The Magnetic Circuit of Transformers. Cloud versus Open. (Illust'd and cont'd.) Photometers. (Illustrated.)

THE ELECTRICAL ENGINEER: *w.* 10c. New York. April 8. Experiments on the Transmission of Power at Very High Potentials. (Illustrated.) Rules and Formula for Incandescent Lamp Wiring. (Cont'd.) April 15. Regulation of Constant Current Generators. (Illust'd.) Mr. Alex. Dow.

THE ENGINEER: *w.* 6d. London. Compound Marine Engines Sixty Years Ago. (Illust'd and cont'd.)

MANUFACTURERS' RECORD: *w.* 10c. Baltimore, Md. Shall the Nation Build Highways?

ENGINEERING AND MINING JOURNAL: *w.* 10c. March 28. Mineral Resources of Alaska. Ivan Petroff. Chemical Literature of the Mineral Waxes. Dr. Henry Wurtz. Notes on Safety Lamps. Herbert W. Hughes, F. G. S. A. R. S. M. April 4. Slow-Burning Mill Construction. (Illust'd.) Iron and Coal Industries of Staunton, Va. (Illust'd.) Experiments in Zinc Desilverization. (From the German.) H. Roessler and B. Edelmann.

Production of Coal West of the Mississippi River. John H. Jones. April 11. Redemption of Egypt. (Special contribution.) Chlorination of Gold Ores. J. H. Burfeind. Juneau, Alaska. Notes on the Dan River Coal Basin. H. B. C. Nitze, E. M. April 18. Production of Copper in 1890, With Tabulated List of the Principal Sources of Copper in the World and Their Outputs. Lixiviation.—Explanation of Obscure Points. C. H. Aron. Manufacture of Sulphuric Acid. (Illust'd and concluded.) April 25. Progress in Heating Processes and in Manufacture of Heavy Chemicals for the Year 1890, Prof. G. Lunge, Ph. D., of the Polytechnic School, Zurich. The New Croton Aqueduct. J. P. Carson. The Granite Industry of the United States. William C. Day. Determination of Small Amounts of Carbon in Cast-iron and Steel. Adolphe Carnot.

SCIENTIFIC AMERICAN: *w.* 10c. April 11. Electroplating the Dead. (Illust'd.) Photography as it Was and Is. Nicolas Pike, First President of the Brooklyn Photographic Society. Automatic Saw-Dust Feed for Furnaces. (Illust'd.) April 18. Centennial Celebration of the Establishment of the U. S. Patent System. (Illustrated with exterior and interior views of the Patent Office, and portraits.) The Illinois State Building at the World's Fair. (Illustrated.)

SCIENTIFIC AMERICAN SUPPLEMENT: *w.* 10c. March 28. The New Labor Exchange at Paris, France. (Illustrated with exterior and interior views.) The Business End of the American Newspaper. A. H. Siegfried. Floating Elevator and Spoil Distributor. (Illust'd.) April 11. "Nickel-in-the-Slot" Machines. (Profusely illust'd.) W. L. Aughinbaugh. Associated Journalism. Paul Wilcox. Electrical Units of the Present and Future. Prof. Francis B. Crocker. April 18. A Great Dynamo for the Paris Central Lighting Station. (Illustrated.) How to measure the Invisible. Henry M. Parkhurst.

ELECTRIC RAILWAY ADVERTISER: *m.* $1 per year. Boston. April. The Short Gearless Motor for Railways. (Illustrated.) How to Wind Drum Armatures (Illustrated and continued.) F. M. Weymouth.

ENGINEERING NEWS: *w.* 12c. New York. April. The Steam-jet as a Means of Preventing Smoke From Boiler Furnaces. (Illust'd.) Artesian Well Practice in the Western United States. European Experience With Traction Engines. (Illust'd.) April 11. Stone Arch Highway Bridge Over the Turkey River, Elkader, Iowa. (Illust'd.) Filter Gallery Washing at Eureka, Cal. Railway Construction in the States East of Chicago. April 18. Comparative Merits of Various Systems of Car Lighting. Computing Areas From Cross-Section Notes. (Illust'd.) The Columbia River Jetty. (Illust'd.) April 25. The Proposed Firth and Clyde Ship Canal. (With map.) Water-Motors.—Cost of Running Economy, etc. Riveted Steel Pipes. D. J. Russell, Assoc. M. Institute C. E., etc.

LOCOMOTIVE ENGINEER: *m.* 10c. Illinois. Throttle and Reverse Lever. (Illust'd.) Locomotive Running Repairs. L. C. Hitchcock. The Coming Locomotive. Test of the Commingler Storage System of Car Heating and the Automatic Temperature Regulator.

AMERICAN MACHINIST: *w.* 6c. New York. April 2. Modern Development of the Steam Engine. Harris Tabor. Tools for Brass Work. (Illust'd.) Fred. H. Colvin. April 9. Conveniencies in the Machine shop. (Illust'd.) Machinery for Manufacturing Wood Pulp. (Illust'd.) April 16. Foundry, Boiler-Shop and Machine Shop. Designed and Built by the Berlin Iron Bridge Company. (Illust'd.)

AMERICAN JOURNAL OF RAILWAY APPLIANCES: *m.* 25c. New York, April. New Railway Signal. (Illust'd.) New Air Brake (Illust'd.) Novel and Inexpensive T-Rail Bridge (Illust'd.) Railroad President's Gospel of Car-Heating.

STONE: *m.* $2. Yearly. Indianapolis, Ind. Practical Granite Cutting. (Illust'd and cont'd.) J. N. Kelley. Notes on Quarrying. (Illust'd.) Wm. L. Saunders. Marble Production in the United States. (Illust'd.) Evolution of Memorial Art. (Illust'd and cont'd.)

MANUFACTURER'S RECORD: *w.* 10c.

Baltimore. April 25. South Carolina Phosphates. History of a Great Industry.

SCIENCE: *w.* 10c. University Extension and the University of the Future. Richard A. Moulton, A. M., Cambridge University, England. Souring of Milk during Thunder Storms, Aaron L. Treadwell. April 10. Malaria and the Causation of Intermittent Fever. The Chemical Society's Jubilee.

BOSTON JOURNAL OF COMMERCE: *w.* 6c. April 4. Some Forms of Gear-wheel Teeth. Steam Boilers—Wear and Tear—Boiler Explosions. Finishing Woolen and Worsted Textures. (Illust'd and cont'd.) Carding Cotton, Joseph Nasmith.

THE COLLIERY ENGINEER: *m.* $2 per year. Scranton, Pa. March. Principles and Practice of Coal-Mining on the Pillar Systems. (Illust'd.) W. S. Grisley, M. E. Particulars of Colliery Explosions from Fire-Damp and Coal-Dust in England and Scotland in 1889. (Illust'd.) A. A. Atkinson.

THE STREET RAILWAY JOURNAL: *m.* 35c. World Building, New York; 25 Rialto Building, Chicago. Report of High Speed Electric Railway Work. (Illust'd.) O. T. Crosby. Street Railway Track. Thomas A. Gibbon.

THE RAILWAY GAZETTE: *w.* $4.20 per year. 73 Broadway, New York. April 10th. Tunnelling Under Heavy Pressures. Vacancies Affecting the Arch-work. Archibald B. Schenck.

AMERICAN JOURNAL OF RAILWAY APPLIANCES: *m.* 25c. April. Railroad Signals. (Illust'd.) First paper. James F. Hobart.

INDIA RUBBER WORLD: *m.* 35c. World Building, New York. April. Pioneers of the Rubber Trade, with Portrait of Charles Macintosh. Collection of Rubber, Methods of Collecting and Sources of Supply.

WESTERN ELECTRICIAN: *w.* 10c. 6 Lakeside Building, Chicago; 534 Temple Court, New York. April 11. Regulation of Constant Current Generators. Alex. Dow. April 25. Electric Street Cars in Buda Pesth, Hungary. (Illust'd.) An English Electric Light Plant. (Illust'd.) Proposed Electric Building at the World's Fair. (Illust'd Supplement.) The Incandescent Lamp. Thomas Grier.

MANUFACTURER AND BUILDER: *m.* 15c. 83 Nassau St., New York. March. Manufacture of Tin-Plate. F. Linwood Garrison.

AMERICAN ARCHITECT: *w.* 10c. Boston, Mass. March 28. Report of Tests of Fire-proof Arches made for the Denver Equitable Building Company by Messrs. Andrews Jaques & Rantoul, Archts. (Illustrated.) April 4. French Architecture. (Cont'd.)

ELECTRICAL REVIEW: *w.* 4d. London; New York, D. Van Nostrand, 23 Murray and 27 Warren Streets. April 3. Effect of Pressure Upon the Conductivity of Liquids. Practical Photometric Research. (Illust'd and cont'd.) Ralph Conrad Richards. Electric Light Wiring Installations from a Mechanical Standpoint.

AMERICAN JOURNAL OF SCIENCE: *m.* 50c. New Haven, Conn. High Level Shores of the Great Lakes and Their Deformation. J. W. Spencer. On Gold-colored Allotropic Silver. Part 1 (cont'd), with 3 plates. M. Carey Lea.

THE AMERICAN GEOLOGIST: *m.* 35c. Minneapolis, Minn. April. Geology of the Mother Lode Gold Belt. Harold W. Fairbanks. The Movement of Ice on the Minnesota Lakes. E. N. Atwood.

PHILOSOPHICAL MAGAZINE AND JOURNAL OF SCIENCE: *m.* 2s. 6d. London, Edinburgh and Dublin. April. Kerr's Magneto-optic Phenomenon in the Equatorial Magnetization of Iron. Further Contributions to Dynamometry, or the Measurement of Power. T. H. Blakesley, M. A. M. Inst. C. E.

THE JOURNAL OF THE FRANKLIN INSTITUTE: *m.* 50c. Philadelphia, Pa. Riveted Joints in Boiler Shells. William Barnet Le Van. Maximum Steam Jacket Efficiency. Prof. Robert H. Thurston.

THE PHOTOGRAPHIC TIMES: *m.* 25c. April. Photographic Color Tones. Julius Schnauss. Effect of Electricity on Dry Plates. (Cont'd.) F. C. Beach.

THE STREET RAILWAY GAZETTE: *m.* 25c. Chicago. April. Serpollet Steam Carriage. (Illust'd.) Primary Batteries. Tramways in Chile. (Illust'd.) Francisco W. N. Lodia.